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CANADA  
—  
ANNUAL REPORT  
OF THE  
MINISTER OF PUBLIC WORKS  
FOR THE FISCAL YEAR 1890-91  
ON THE WORKS UNDER HIS CONTROL.  
  
PART I.

SUBMITTED IN ACCORDANCE WITH THE PROVISIONS OF CHAPTER THIRTY-SIX,  
SECTION 3, OF THE REVISED STATUTES OF CANADA.

PRINTED BY ORDER OF PARLIAMENT



OTTAWA

PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST  
EXCELLENT MAJESTY

1892

[S. E. D. 8—1891.] Price 20 cents.



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- 920 -

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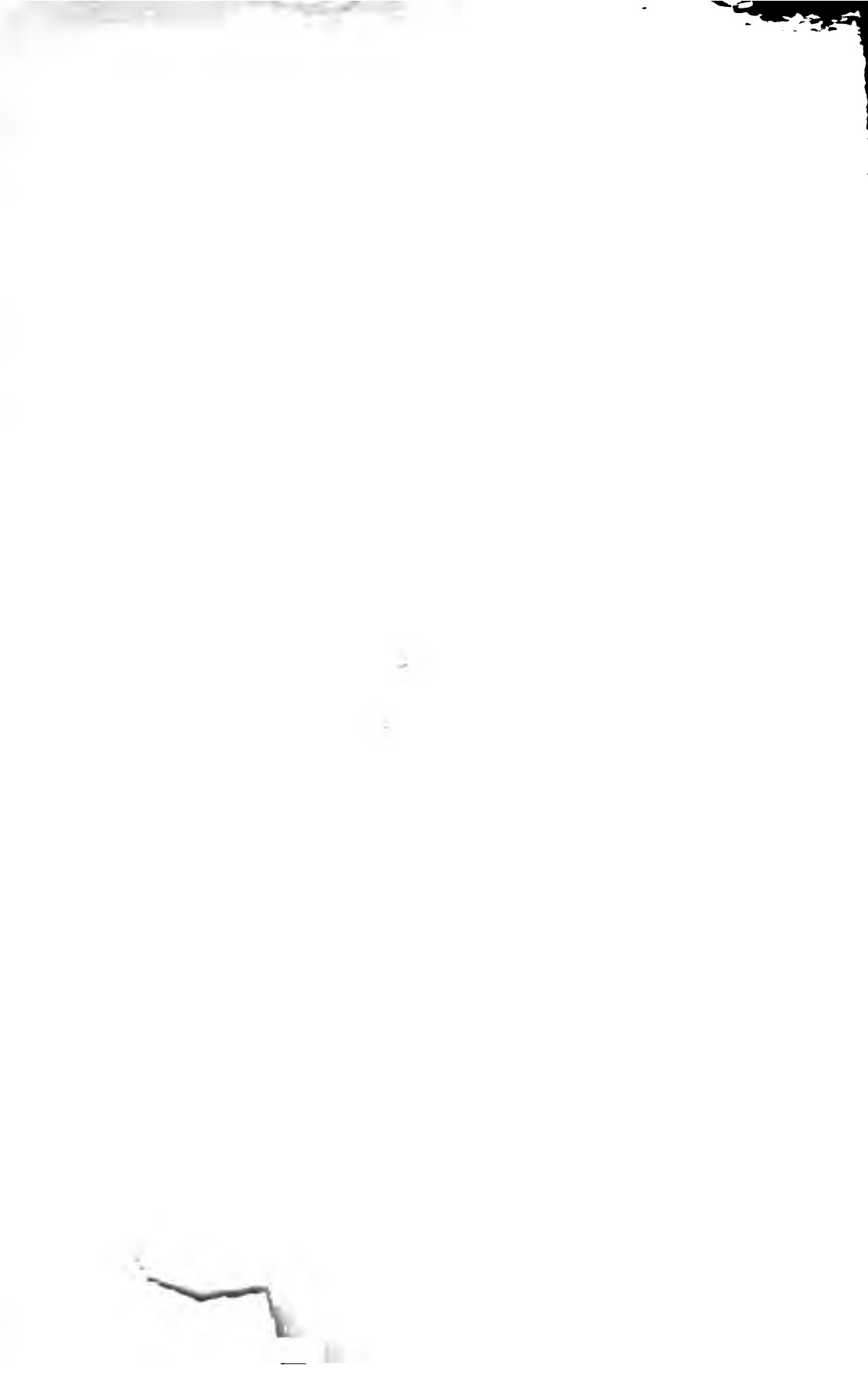
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CANADA.

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REPORT

OF THE

MINISTER OF PUBLIC WORKS

FOR THE

FISCAL YEAR ENDED 30<sup>TH</sup> JUNE 1891.

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*To His Excellency the Right Honourable Sir Frederick Arthur Stanley, Baron Stanley of Preston, in the County of Lancaster, in the Peerage of Great Britain, Knight Grand Cross of the Most Honourable Order of the Bath, Governor General of Canada, and Vice Admiral of the same, &c.*

MAY IT PLEASE YOUR EXCELLENCY:

In compliance with the requirements of Chapter 36, Section 37, of the Revised Statutes of Canada, I have the honour to present to Your Excellency the Annual Report of the Department of Public Works, for the fiscal year ended 30th June, 1891.

Respectfully submitted,

J. ALD. OUIMET,  
*Minister of Public Works.*

OTTAWA, 10th March, 1892.



## DEPARTMENT OF PUBLIC WORKS,

OTTAWA, 9th March, 1892.

To the Honourable

JOSEPH ALDRIC OCIMET,  
Minister of Public Works.

SIR,—I have the honour to submit the annual report of the Department of Public Works, for the fiscal year ended 30th June, 1891,

The report contains references to the more important works performed under the direction and superintendence of the department, during the year.

In the numerous appendices annexed thereto, detailed accounts of the expenditure will be found, with reports by officers of the department, on the extent and nature of the services performed, in constructing, repairing and maintaining the public buildings, harbours, government telegraph lines, slides and booms, &c., throughout the Dominion.

The works under the control of the department are :—

BUILDINGS (PUBLIC), their construction and maintenance.

DREDGING AND DREDGE VESSELS.

HARBOURS AND PIERS, their construction and maintenance.

ROADS AND BRIDGES.

SLIDES AND BOOMS, and the collection of revenue therefrom.

TELEGRAPHS.

WORKS ON NAVIGABLE RIVERS.

For convenience of reference, the following brief résumé of the work performed has been, as far as practicable, arranged alphabetically :—

## ART GALLERY NATIONAL.

“MORTGAGING THE FARM.”—An oil painting by G. A. C. Reid, R.C.A., was this year handed over to the Government by the Royal Academy, and placed with the collection in the National Art Gallery.

The number of visitors who registered their names during each fiscal year since the gallery was inaugurated have been as follows :—

1882-83	8,261
1883-84	9,928
1884-85	11,893
1885-86	8,792
1886-87	11,943
1887-88	16,593
1888-89	14,241
1889-90	18,048
1890-91	21,289

The curator's report is added hereunto, in Appendix No. 12, page 189.

## ACTS OF PARLIAMENT.

**LAW AMENDMENTS.**—A list of the acts passed during the last session of Parliament, having reference to the Department of Public Works, is given in Appendix No. 20, page 231.

## BRITISH COLUMBIA.

**BUILDINGS.**—Public buildings have been erected, extended, improved, repaired or fitted up at the following places during the fiscal year :—

Agassiz experimental farm,	New Westminster,
Albert Head quarantine station,	Vancouver immigrant building,
Kamloops,	Vancouver post office,
Nanaimo,	Victoria barracks.

(See Appendix No. 1, page 8. Appendix No. 2, pages 42-43.)

**HARBOURS AND RIVERS.**—For facilitating, and for the security of navigation, operations for the removal of obstructions by dredging and otherwise, have been carried on at the following harbours and rivers, viz. :—

Columbia River,	Fraser River,
Coquitlam do	Nanaimo Harbour,
Cowichan do	Nicomechel River.

**VICTORIA HARBOUR.** - See Appendix No. 1, page 18. Appendix No. 3, pages 92-93.

## CANAL

**PORT LA TOUR, NOVA SCOTIA.**—A description of the work done in connection with this work will be found in Appendix No. 3, page 67.

## CONTRACTS.

**APPENDIX No. 16,** page 13, contains a statement showing the contracts entered into, the property purchased and sold, and property leased by or to the department, during the fiscal year.

## CORRESPONDENCE.

**APPENDIX No. 11,** page 185, shows a statement of the official correspondence of the department, together with that of its principal officials from 1867 to the 30th June, 1891.

## DOMINION BUILDINGS.

**APPENDIX No. 1,** pages 9 to 13, is a statement by provinces, showing the amounts expended for heat, light and water, for the use of the several public buildings throughout Canada for the fiscal year.

## DREDGES.

**DREDGING OPERATIONS.**—The report on the operations of the various dredges in the different provinces is appended in Appendix No. 3, pages 95 to 134.

## ENGINEERS, ENGINEMEN, FIREMEN AND CARETAKERS.

**EMPLOYÉS.**—A list of the engineers, &c., employed in the public buildings throughout Canada, with a statement showing date of birth, position, date of appointment and salaries, is added in Appendix No. 4, pages 135 to 139.

(See also Appendix No. 2, page 43.)

## EXPENDITURE.

APPENDIX No. 1.—This appendix is a succinct statement, by the accountant of the department, of the expenditure on the various services during the fiscal year.

## GEODETIC LEVELLING.

Part II of this report is a continuation of Mr. R. Steckel, C. E.'s report, respecting the determination of the water line along the River St. Lawrence, between the cities of Montreal and Quebec. The field work, including tide and river gauging, and levelling operations, in connection with the geodetic levelling of the River St. Lawrence, was commenced in 1885 and completed in 1888. Prior to 1889 Parliament made three special appropriations, amounting in the aggregate to \$8,000, for this work. The technical office work, however, was performed in this department by employés under the direction and superintendence of Mr. Steckel, who attended thereunto in addition to his other office duties.

Remarks on Mr. Steckel's work by the acting chief engineer of the department will be found with the report, in Part II.

## GRAVING DOCKS.

ESQUIMALT GRAVING DOCK.—A report on the operations of this dock will be found in Appendix No. 3, page 93.

KINGSTON GRAVING DOCK.—This work was nearly completed at the end of the fiscal year. (See Appendix No. 3, Page 87.)

LÉVIS GRAVING DOCK.—This dock was under the control of the Quebec Harbour Commissioners until October, 1890, when the department assumed the management thereof. Since then some necessary improvements were supplied and the dock kept in good order. (See Appendix No. 3, page 78.)

The dimensions of the graving docks in Canada are as follows, viz. :—

Names of Docks.	Length.	Width at Coping Level.	Width at En- trance.	Width at bottom.	Water on Sills at Ordin- ary Spring Tides.	Spring Tides rise.	Neap Tides rise.
Esquimalt graving dock.....	430	90	65	41	26½	7 to 10	5 to 8
Halifax do .....	585	102	89½	72	30	6	3
Kingston do .....	280	79	55	47	15½	*	.....
Lévis do .....	495	100	62	73	25½	18	13

\* Height of water varies 3½ feet.

A statement giving the names, salaries, &c., of persons employed on the graving docks is annexed in Appendix No. 13, page 193.

## LOCKS AND DAMS.

RIVER DU LIÈVRE, P.Q.—It is expected that by the end of autumn the dam across the river will be completed, the lock utilized and the whole work finished. (*See* Appendix No. 1, page 16. Appendix No. 3, page 80.)

YAMASKA, P.Q.—The repairing of a break in the dam was not finished, as the appropriation was exhausted. Two shoals below the lock were cut through, and 16,988 yards of clay, &c., removed. 7,744 yards of material were removed by dredging from the channel above the lock. (*See* Appendix No. 1, page 16. Appendix No. 3, page 83.)

OROMOCTO SHOALS ("Shear Dam"), N.B.—Repairs and replacements were effected in connection with this work during the fiscal year. (*See* Appendix No. 1, page 15. Appendix No. 3, page 81.)

## MAJOR'S HILL PARK.

The contract for the maintenance and improvement of Major's Hill park has been renewed for three years. The park was kept in good order. It has become shady and attractive, and a popular public resort. (*See* Appendix No. 2, page 36.)

## NAVIGATION, OPENING AND CLOSING OF.

DATES.—At page 196, Appendix No. 14, is given an alphabetically arranged list of the principal ports of Canada, showing the date of the formation of ice, and the closing of navigation thereby at each place, in 1890, also the date when the navigation opened in 1891, &c.

This information was kindly furnished to the department by the custom house officers at the respective ports.

## NEW BRUNSWICK.

BREAKWATERS.—At each of the following places breakwaters were either commenced, repaired or extended during the fiscal year, viz. : —

Anderson's Hollow,	Shippegan,
Gray's Island,	Tynemouth Creek.
Negro Point,	

(*See* Appendix No. 1, page 15. Appendix No. 3, pages 70 to 75.)

BUILDINGS.—Repairing and improving the following public buildings engaged the attention of the department last fiscal year, viz. : —

Bathurst,	St. John quarantine station,
Carleton,	do custom house,
Chatham,	do cattle quarantine,
Dalhousie,	do marine hospital,
Fredericton,	do post office,
Moncton,	do savings bank.
Sackville,	

(*See* Appendix No. 1, page 3. Appendix No. 3, pages 27 to 29.)

**HARBOURS.**—Improvements by dredging, &c., were executed at the following places, viz. :—

Carraquet,	Richibucto.
Pointe du Chêne,	St. John (Negro Point).

(See Appendix No. 1, page 15. Appendix No. 3, pages 70 to 75 and 122.)

**PIERS.**—Extensive works are in progress at Cape Tormentine for the purpose of forming a harbour. (See Appendix No. 1, page 15. Appendix No. 3, pages 70 to 75.)

**WHARVES.**—Two ballast wharves, and one for general purposes, were under construction during the fiscal year at the following places, viz. :—

Campbellton,	Kingston.
Edgett's Landing,	

(See Appendix No. 3, pages 71-72.)

### NORTH-WEST TERRITORIES.

**BRIDGES.**—The Belly River bridge, Lethbridge, has been completed, and a bridge across Old Man's River is in course of construction. For particulars see Appendix No. 3, page 92.

**BUILDINGS.**—The following named buildings and other edifices for public purposes, were constructed, improved or fitted up during the year, viz. :—

Calgary barracks,	Regina barracks,
do court house,	do council chamber,
Indian Head experimental farm,	do court house,
Lethbridge barracks,	do gaol, &c.,
Macleod do	do immigration building,
do outposts,	do industrial building,
Maple Creek barracks,	do governor's residence.
Moosomin court house,	Whitewood, immigration building.
Qu'Appelle immigration building,	

(See Appendix No. 1, page 6. Appendix No. 2, pages 39 to 42.)

### NOVA SCOTIA.

**BREAKWATERS.** The following named breakwaters, were repaired, reconstructed or extended during the last fiscal year, viz. :—

Church Point,	Margaretville,
Cow Bay,	McNair's Cove,
Economy,	Port George,
French River,	Port Hood,
Harbourville,	Port Maitland,
Joggins,	Stony Island,
Jordan Bay,	Walton.

(See Appendix No. 1, page 14. Appendix No. 3, pages 56 to 70.)

**BUILDINGS.** —The following public buildings have been repaired, improved, extended or completed during the last fiscal year, viz. : —

Annapolis,	New Glasgow,
Antigonish,	Pictou custom house,
Dartmouth,	Pictou quarantine station,
Halifax Dominion building,	Sydney,
do examining warehouse,	Truro,
do immigration building,	Windsor.
Nappan experimental farm buildings,	

(See Appendix No. 1, page 3. Appendix No. 2, pages 25 to 27.)

**HARBOURS.** During the last fiscal year improvements were made to the under-mentioned harbours by dredging, protection work or other means, viz. :

Cariboo,	Pictou,
Cheticamp,	Port George,
Mabou,	Port Maitland,
Margaree,	Tatamagouche,
Margaretville,	Tracadie,
Merigomish,	Walton,
Meteghan,	Weymouth.

(See Appendix No. 1, pages 14 and 18. Appendix No. 3, pages 56 to 70.)

**PIERS.**—Piers have either been reconstructed, repaired or extended at the following places during the fiscal year, viz. : —

Digby,	Port Latour,
Lobster Rocks,	Port Maitland,
Ogilvie's,	Victoria.

(See Appendix No. 1, page 14. Appendix No. 3, pages 56 to 70.)

**WHARVES.** —Public wharves have been constructed, repaired or extended at each of the undermentioned places during the year, viz. : —

Barrington,	Irish Cove,
Broad Cove,	Lismore,
Brulé,	Little Brook,
Cheticamp,	Merigomish,
Cribbin's Point,	South Gut,
Economy,	South Ingonish,
Georgeville,	Summerville,
Great Village,	Tidnish,

(See Appendix No. 1, page 14. Appendix No. 3, pages 56 to 70.)

#### OFFICIALS.

APPENDIX No. 9 is a statement giving the names, with the dates of appointments, &c., of the chief officers of the Department of Public Works, from 1841 to 1892.

#### ONTARIO.

**BREAKWATER.** The extension of Wiarton Harbour breakwater was completed during the year.

(See Appendix No. 3, page 91.)

**BUILDINGS.**—Public buildings have been commenced, completed, extended, repaired, or fitted up and improved during the fiscal year at the following places, viz :—

Almonte,	Orillia,
Brampton,	Peterborough,
Brockville,	Petrolea,
Carleton Place,	Port Arthur,
Cobourg,	Prescott,
Gananoque,	Smith's Falls,
Goderich,	Stratford,
Guelph,	St. Thomas,
Hamilton,	Toronto.
Ottawa,	

(See Appendix No. 1, page 4. Appendix No. 2, pages 33 to 39.)

**CHANNELS, &c.**—Dredging or other operations to improve the channel and facilitate navigation were performed in connection with the following rivers, channels, &c., during the last fiscal year, viz :—

Clapperton Channel,	Port Albert,
Kaministiquia River,	Rideau River,
Little Current,	Saugeen River,
Meaford,	Shannonville,
Ottawa River,	Sydenham,
Parry Sound Narrows,	Trenton,
Pickering,	Whitby.

(See Appendix No. 1, page 17. Appendix No. 3, pages 86 to 91.)

**HARBOURS.**—The improvement of the following harbours engaged the active attention of the department during the fiscal year. A description of the work done at each will be found in Appendix 3, pages 86 to 91 :—

Belleville,	Meaford,
Big Bay,	Owen Sound,
Kingston,	Penetanguishene,
Kincardine,	Warton breakwater.

**PIERS.**—In Appendix No. 3, pages 86 to 91, will be found a description of the work done to the following piers, viz :

Beaverton,	Port Hope,
Bowmanville,	Portsmouth,
Kingsville,	Rondeau.
Port Elgin,	

#### PARLIAMENT HILL GROUNDS.

**CONTRACT.**—The contract for the keeping and dressing of the Parliament grounds was renewed for three years. The grounds presented the usual neat and attractive appearance.

(See Appendix No. 2, page 36.)

## PRINCE EDWARD ISLAND.

**BREAKWATERS.** The breakwaters at the following places were repaired, extended or reconstructed during the fiscal year, viz. :—

Campbell's Cove,	Rustico (North).
Malpeque,	Souris.
New London,	

(See Appendix No. 1, page 15. Appendix No. 3, page 47.)

**BUILDINGS.** Improvements in connection with the Dominion building, Charlottetown, and grounds, were effected.

(See Appendix No. 1, page 9. Appendix No. 2, page 29.)

**HARBOURS.** Harbour improvements were executed at the following places, viz.

Cascumbee,	New London.
Gauthier's Creek,	Rustico.
Miminegash,	

(See Appendix No. 1, page 15. Appendix No. 3, page 47.)

**PIERS.** The following piers were repaired, rebuilt or extended during the fiscal year, viz. :

Annandale,	Pinette.
Bay View,	Port Seakirk.
Belfast,	Pownal.
Cardigan,	Red Point.
Chapel Point,	Rustico (South).
China Point,	St. Mary's Bay.
Georgetown,	Stevens.
Hickey's,	Sturgeon.
Hurd's Point,	Victoria.
Kier's Shore,	

(See Appendix No. 1, page 5. Appendix No. 3, pages 47 to 50.)

## PUBLIC BUILDINGS AND GROUNDS, OTTAWA.

**MAINTENANCE.** The heating, lighting, oil and water services in connection with the Parliament and other public buildings in the capital were maintained with efficiency and due regard to improvement and economy.

Details are given in Appendix No. 2, pages 35 to 37, and Appendix No. 5, page 44.

## QUEBEC.

**BREAKWATERS.** Damage to the breakwater at Etang du Nord by a storm was repaired, and a contract entered into for the construction of an isolated dock of crib-work at Ste. Anne des Monts. Crib-work protection, etc., was also provided at Gatineau Point, Boucherville and River L'Assomption.

(See Appendix No. 1, page 16. Appendix No. 3, pages 75 to 82.)

**BUILDINGS.**—Improvements, repairs, additions or extensions were made to the following public buildings and institutions during the fiscal year, viz. :

Aylmer,	Quebec cullers' office,
Chicoutimi,	do citadel,
Coaticook,	do examining warehouse,
Fraserville,	do post office,
Grosse Isle quarantine station,	Richmond,
Hull,	St. Henri,
Joliette,	St. Hyacinthe,
Lachine,	St. Vincent de Paul penitentiary,
Montreal custom house,	St. Jérôme,
do examining warehouse,	Three Rivers,
do inland revenue office,	do do Platon,
do post office,	Valleyfield.

(See Appendix No. 1, page 4. Appendix No. 2, pages 29 to 33.)

**HARBOURS.**—The dredge “Nipissing” operated on the channel at Lachine and at Beauharnois, and a large quantity of solid rock, &c., was removed from Point St. Pierre harbour.

(See Appendix No. 1, page 19. Appendix No. 3, page 78.)

**LAND SLIDE.** The River Champlain was dammed by a land slide. The obstruction was removed.

(See Appendix No. 1, page 16. Appendix No. 3, page 81.)

**PIERS.** During the past fiscal year, piers have been commenced, completed, repaired or extended at the following places, viz. :—

Belœil,	Rivière des Prairies,
Lake Megantic,	River Richelieu,
Longueuil,	St. Anicet,
Newport River,	Ste. Anne de Sorel,
Nicolet River,	St. Siméon,
Rimouski,	St. Timothée.

(See Appendix No. 1, page 16. Appendix No. 3, pages 75 to 85.)

**SLIPS.** The movable slip at Berthier (*en bas*), broken in the fall of 1889, was replaced, and at Kamouraska the old wharf was replaced by an inclined slip.

(See Appendix No. 1, page 16. Appendix No. 3, pages 76 and 78.)

**WHARVES.**—The requirements of public wharves have been attended to by the department at the following places, during the fiscal year, viz. :

Anse St. Jean,	Rivière du Loup,
Baie St. Paul,	Ste. Famille,
Beauport,	St. François,
Cap à l'Aigle,	St. Jean d'Orléans,
Cap de la Madeleine,	St. Laurent,
Cedars,	St. Michael,
Coteau Landing,	Three Rivers.
Grosse Isle,	Trois Pistoles,
Rivière Ouelle,	

(See Appendix No. 1, page 16. Appendix No. 3, pages 75 to 85.)

## ROADS AND BRIDGES.

**CONSTRUCTION, &c.** — A detailed account of the expenditure on roads and bridges will be found in Appendix No. 1, and a description of the work done in Appendix No. 3.

## SLIDES AND BOOMS. -

**COLLECTOR'S REPORT.** — The report of the collector of slide and boom dues for the fiscal year will be found at page 201 of Appendix No. 15.

To this report eight statements are attached, viz : -

1st. Showing the dues accrued on the Government slides and works, on the River Ottawa and its tributaries, during the fiscal year ended 30th June, 1891.

2nd. Statement of the number of pieces of timber, saw-logs, &c., that passed through the Government slides and works on the River Ottawa and its tributaries, during the fiscal year ended 30th June, 1891.

3rd. Statement of slidage and boomage from Ottawa slides and works, outstanding 30th June, 1889, and remaining uncollected 30th September, 1891.

4th. Statement of slide and boom dues accrued from Ottawa River works since 1st July, 1889, outstanding on 30th June, 1891, and remaining uncollected on 30th September, 1891.

5th. Statement of outstanding slide dues, Ottawa district, bonds for which were sent to Quebec for collection, remaining unpaid 30th September, 1891.

6th. Statement of slides and boom dues from the St. Maurice slides and works, outstanding on 30th June, 1891, and remaining uncollected on the 30th September, 1891.

7th. Statement of slide dues accrued at the Saguenay, outstanding on the 30th June, 1891, unpaid 30th September, 1891.

8th. Statement of dues accrued at Fenelon Falls, Ont., outstanding on the 30th June, 1891, unpaid 30th September, 1891.

**NEWCASTLE DISTRICT.** — A detailed description of the repairs executed, and a statement showing the quantities of timber that passed through the slide is inserted at page 153, Appendix No. 7.

**OTTAWA DISTRICT.** — A detailed report on the work done, under the direction of the department, will be seen on reference to Appendix No. 6, page 147.

**SAGUENAY DISTRICT.** — The report of the superintendent of slides in this district is attached at page 227, Appendix No. 19.

**ST. MAURICE DISTRICT.** — The expenditure in connection with the maintenance of the St. Maurice district works exceeded the appropriation of \$16,600 by the sum of \$118.53. Of the \$5,800 appropriated for repairs a balance of \$1,812.59 remained unexpended at the end of the fiscal year. Details of the expenditure are given in Appendix No. 18, page 223.

**STAFF EMPLOYED.** In Appendix No. 10, page 180, is given a list showing the names, date of birth, where employed, date of appointment and salary of each one of the staff employed on all the slides and booms in Canada.

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## SURVEYS AND EXAMINATIONS, &c.

**PRELIMINARY.**—Surveys, examinations and reports were made at 130 different localities by officers of the department during the fiscal year, a list of which will be found in Appendix No. 3, pages 93 and 94.

## TELEGRAPHS.

**ANNUAL OPERATIONS.**—Two submarine cables were successfully submerged during the year, one from Long Point of Mingan, north shore of St. Lawrence to Mechastie Bay. Anticosti, distance  $20\frac{1}{2}$  miles and the other from Meat Cove, C.B., Nova Scotia, to the Island of St. Paul's, at the entrance of the Gulf of St. Lawrence, between Nova Scotia and Newfoundland. The length of this cable is 20·4 nautical miles.

Important improvements to, and extension of, the Government telegraph system were also carried on in all the provinces of the Dominion, the particulars of which are attached in the superintendent's report, Appendix No. 8, page 157.

I have the honour to be, Sir,

Your obedient servant,

A. GOBEIL,

*Deputy Minister*



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**APPENDIX No. 1.**

**STATEMENT OF EXPENDITURE**

**DURING FISCAL YEAR ENDED 30<sup>TH</sup> JUNE, 1891,**

**BY**

**O. DIONNE, ACCOUNTANT.**

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## APPENDIX No. 1.

(Reference No. 126358.)

STATEMENT showing the amount expended by the Department of Public Works,  
Dominion of Canada, during the Fiscal Year ended 30th June, 1891.

Name of Work.	Con- struction and Im- provements.	Repairs.	Staff and Main- tenance.	Total.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.
<b>PUBLIC BUILDINGS.</b>				
GENERALLY .....			12,402 35	12,402 35
<i>Novu Scotia.</i>				
Amherst Post Office, &c. ....		50 66		50 66
Annapolis do .....	9,961 72			9,961 72
Antigonish .....		172 15		172 15
Halifax Dominion Building .....	2,314 50	1,776 91		4,091 41
do Examining Warehouse .....		1,606 06		1,606 06
do Immigrant Building .....	2,515 98	974 59		3,490 57
do Penitentiary .....		0 20		0 20
Nappan Experimental Farm .....	1,205 67			1,205 67
New Glasgow Post Office, &c. ....		66 26		66 26
North Sydney do .....		28 99		28 99
Pictou Marine Hospital .....		15 00		15 00
do Post Office .....		136 40		136 40
do Quarantine Station .....		604 44		604 44
Sydney (South) Post Office, &c .....	7,396 25			7,396 25
Truro Post Office, &c .....		749 77		749 77
Windsor do .....		184 24		184 24
Yarmouth do .....		51 50		51 50
<i>Prince Edward Island.</i>				
Charlottetown Dominion Building .....	1,971 01	1,111 91		3,082 92
Montague Post Office, &c .....		17 31		17 31
Summerside do .....		14 75		14 75
<i>New Brunswick.</i>				
Bathurst Post Office, &c. ....		223 87		223 87
Carleton (St. John) Post Office .....		381 71		381 71
Chatham Post Office, &c .....	104 36			104 36
Dalhousie do .....	3,727 52			3,727 52
Fredericton do .....	1,969 10	44 00		2,013 10
Newcastle do .....		47 47		47 47
Partridge Island Quarantine Station .....		18 94		18 94
Portland Post Office .....		130 90		130 90
St. John Cattle Quarantine Station .....	259 00			259 00
do Custom House .....		2,641 40		2,641 40
do Inland Revenue Office .....		20 00		20 00
do Marine Hospital .....		389 65		389 65
do Post Office .....		651 75		651 75
do Savings Bank Building .....		849 42		849 42
St. Stephen Post Office, &c .....		17 01		17 01
Sussex do .....		44 35		44 35
Woodstock do .....		97 87		97 87
Carried forward .....	31,425 11	13,119 48	12,402 35	56,946 94

## APPENDIX No. 1—Continued.

Name of Work.	Con- struction and Im- provements.	Repairs.	Staff and Main- tenance.	Total.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.
<b>PUBLIC BUILDINGS—Continued.</b>				
Brought forward.....	31,425 11	13,119 48	12,402 35	56,946 94
<i>Quebec.</i>				
Aylmer Post Office, &c.....		39 25		39 25
Chicoutimi Marine Hospital.....	1,089 10	63 16		1,152 26
Coaticook Post Office, &c.....		54 97		54 97
Grosse Ile Quarantine Station.....	15,932 18			15,932 18
Hull Post Office, &c.....	471 99			471 99
Joliette do.....	306 93			306 03
Lachine do.....	7,182 50			7,182 50
Laprairie do.....	5 00			5 00
Montreal Custom House, Renewals, &c.....	9,406 10	305 50		9,711 60
do Sanitary Work.....	752 50			752 50
Montreal Examining Warehouse.....	2,837 64	445 46		3,283 10
do Immigration Building.....		2,812 42		2,812 42
do Inland Revenue Office—Sanitary Works.....	1,547 50			1,547 50
do do.....		207 08		207 08
do Post Office.....	3,033 40	1,043 37		4,076 77
do do Electric Lighting Extension.....	962 47			962 47
Quebec Citadel Buildings.....		2,099 93		2,099 93
do Clerk of Works Office.....		948 00		948 00
do Cullers' Office.....		123 32		123 32
do Custom House.....		3,077 56		3,077 56
do Examining Warehouse.....		271 47		271 47
do Immigrant Buildings.....		312 21		312 21
do Inland Revenue Office.....		10 00		10 00
do Marine Hospital.....		22 01		22 01
do Old Parliament Building Grounds.....		178 49		178 49
do Post Office.....		1,136 03		1,136 03
do Queen's Wharf Building.....		452 67		452 67
do Weights and Measures Office.....		59 00		59 00
Rivière du Loup Post Office, &c. (Fraserville).....	6,226 00			6,226 00
Sherbrooke Post Office, &c.....		294 13		294 13
Sorel do.....		177 95		177 95
St. Henri do.....	419 20			419 20
St. Hyacinthe do.....	6,351 60			6,351 60
St. Jérôme do.....		265 25		265 25
St. John's do.....		83 75		83 75
St. Vincent de Paul Penitentiary.....	30,735 32			30,735 32
Three Rivers Custom House.....		810 14		810 14
do Post Office.....		281 40		281 40
Valleyfield do.....		426 00		426 00
<i>Ontario.</i>				
Almonte Post Office, &c.....	14,847 30			14,847 30
Amherstburg Post Office, &c.....		71 89		71 89
Barrie do.....		211 15		211 15
Belleville do.....		215 32		215 32
Berlin do.....		99 51		99 51
Brampton do.....	6,133 48			6,133 48
Brantford do.....		350 49		350 49
Brockville do Sanitary Works.....	499 67	261 01		760 68
Carleton Place do.....	5,116 01			5,116 01
Cayuga do.....	110 00	3 50		113 50
Chatham do.....		61 71		61 71
Cobourg do.....	2,777 19			2,777 19
Carried forward.....	148,168 28	30,394 58	12,402 35	190,965 21

## APPENDIX No. 1—Continued.

Name of Work.	Con- struction and Im- provements.	Repairs.	Staff and Main- tenance.	Total.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.
<b>PUBLIC BUILDINGS -Continued.</b>				
<i>Ontario—Continued.</i>				
Brought forward.....	148,168 28	30,394 58	12,402 35	190,965 21
Cornwall Post Office, &c.....	1,470 00	356 49		1,826 49
Dundas do.....		503 75		503 75
Galt do.....		50 00		50 00
Gananoque Custom House.....	2,015 71	55 00		2,070 71
Goderich Post Office, &c.....	6,718 09			6,718 09
Guelph do.....		229 41		229 41
Hamilton Immigrant Building.....		147 85		147 85
do Post Office.....		409 96		409 96
Kingston Civil Service Examination Office.....		18 25		18 25
Kingston Custom House.....		644 49		644 49
do Military College, new dormitory.....	257 01			257 01
do Penitentiary.....	146 50			146 50
do Post Office.....		943 61		943 61
Lindsay do.....	4,825 32	36 23		4,861 55
London Civil Service Examination Office.....		75 00		75 00
do Custom House.....	1,779 60	29 00		1,808 60
do Immigrant Building.....		46 00		46 00
do Infantry School.....	22 95			22 95
do Military Buildings.....		95 00		95 00
do Post Office.....		1,705 07		1,705 07
Napanee do &c.....		263 88		263 88
Niagara Falls Post Office.....		5 00		5 00
Orangeville do.....		47 67		47 67
Ottawa Examining Warehouse.....		1,114 99		1,114 99
do Experimental Farm.....	11,413 54			11,413 54
do Geological Museum.....		1,965 84		1,965 84
do do lighting.....			662 20	662 20
do Government Printing Bureau.....	41,846 13	118 03		41,964 16
do do do lighting.....			2,150 85	2,150 85
do Major's Hill Park.....			5,879 55	5,879 55
do National Art Gallery.....			777 43	777 43
do Post Office.....	453 25	2,251 25		2,704 50
do do lighting.....			1,804 70	1,804 70
do Public Buildings—Renewing roofs, boiler houses.....	3,012 74	127,648 71		130,661 45
do do East Block, closets.....	1,299 98			1,299 98
do do do new vault, Finance Department.....	8,458 77			8,458 77
do do West Block, new sky-light, Copper roofing, Parliament Building.....	1,345 60			1,345 60
do do Langevin Block.....	1,631 23			1,631 23
do do do lighting.....	61,572 77	2,569 36		64,132 13
do do do snow.....			1,055 40	1,055 40
do do Gas and electric light.....			875 00	875 00
do do Grounds.....			19,255 74	19,255 74
do do do re Marshall Wood.....			5,935 21	5,935 21
do do Heating.....	20 00			20 00
do do Snow.....			59,925 88	59,925 88
do do Telephonic service.....			1,176 11	1,176 11
do do Water.....			3,218 75	3,218 75
do Supreme Court, addition.....			15,017 19	15,017 19
do Victoria Hall.....	14,561 41	46 00		14,607 41
do do.....		26 13		26 13
Pembroke Post Office, &c.....	9,387 92			9,387 92
Peterborough do.....		73 73		73 73
do New Custom House.....	9,062 23			9,062 23
Carried forward.....	329,469 03	171,850 28	130,136 36	631,455 67

## APPENDIX No. 1—Continued.

Name of Work.	Con- struction and Im- provements.	Repairs.	Staff and Main- tenance.	Total.
<b>PUBLIC BUILDINGS—Continued.</b>	<b>\$ cts.</b>	<b>\$ cts.</b>	<b>\$ cts.</b>	<b>\$ cts.</b>
<i>Ontario—Concluded.</i>				
Brought forward.....	329,469 03	171,850 28	130,146 36	631,455 67
Petrolia Post Office, &c.....	4,053 71			4,053 71
Pictou do.....		12 00		12 00
Port Arthur Immigrant Building.....		70 00		70 00
do Post Office, &c.....	29 35			29 35
Port Colborne do.....		5 40		5 40
Port Hope do.....		119 25		119 25
Prescott do &c.....	18,554 52			18,554 52
Rideau Hall.....		20,152 39		20,152 39
do Fuel and light.....			8,000 00	8,000 00
do Lighting New Edinburgh street.....			200 00	200 00
do Removal of snow.....			475 00	475 00
Seaforth Post Office, &c.....		60 25		60 25
St. Catharines Post Office.....		86 70		86 70
St. Thomas do.....		127 49		127 49
Stratford do.....		153 80		153 80
Strathroy do.....	11,349 25			11,349 25
Toronto Civil Service Examination Office.....		152 43		152 43
do Custom House, Sanitary Works, &c.....	2,185 52	539 82		2,725 34
do Drill Hall.....	137 00			137 00
do Examining Warehouse.....	4,338 90	218 12		4,557 02
do Immigrant Building.....		41 78		41 78
do Inland Revenue Building.....		78 04		78 04
do Military School.....	4 77			4 77
do Post Office.....	5,767 41	631 81		6,399 22
Trenton do.....	2,072 21	3 00		2,075 21
Walkerton do.....	15,497 42			15,497 42
Windsor Inland Revenue Office.....		160 00		160 00
do Post Office, &c.....		317 25		317 25
Woodstock do.....		10 00		10 00
<i>Manitoba.</i>				
Brandon Experimental Farm.....	13,181 97			13,181 97
do Immigrant Building.....		341 60		341 60
do Post Office.....	21,069 90			21,069 90
Minnedosa Immigrant Building.....		256 95		256 95
Public Buildings generally.....			1,022 10	1,022 10
St. Boniface Indian Industrial School.....	8 25			8 25
St. Paul do do.....	695 00			695 00
Stony Mountain Penitentiary.....	1,333 41			1,333 41
Winnipeg Clerk of Works Office.....		2,236 55		2,236 55
do Custom House.....		257 81		257 81
do Dominion Lands Office.....		440 42		440 42
do Examining Warehouse.....		5 75		5 75
do Fort Osborne, Military Buildings.....	128 07			128 07
do Immigrant Buildings.....	16,290 25	598 17		16,888 42
do Intelligence Office.....		13 00		13 00
do Post Office.....		1,351 69		1,351 69
do Savings Bank.....		30 65		30 65
<i>North-West Territories.</i>				
Battleford Mounted Police Barracks.....		7,402 36		7,402 36
do Registrar's House and Office.....	1,176 38			1,176 38
Big Bend, Mounted Police Barracks.....		89 58		89 58
Carried forward.....	447,342 32	207,814 34	139,833 46	794,990 12

## APPENDIX No. 1—Continued.

Name of Work.	Con- struction and Im- provements.	Repairs.	Staff and Main- tenance.	Total.
<b>PUBLIC BUILDINGS—Continued.</b>	<b>\$ cts.</b>	<b>\$ cts.</b>	<b>\$ cts.</b>	<b>\$ cts.</b>
<i>North-West Territories—Concluded.</i>				
Brought forward.....	447,342 32	207,814 34	139,833 46	794,990 12
Battle Immigrant Building .....		276 95		276 95
Bull's Head Mounted Police Barracks .....		93 24		93 24
Calgary Clerk of Works Office .....		14 50		14 50
do Court House, Gaol, Registry Office, &c. ....	8,413 56			8,413 56
do Immigrant Building .....		1,050 19		1,050 19
do Mounted Police Barracks .....		6,520 07		6,520 07
do Post Office, Custom House, &c. ....	50 45			50 45
Coutts Mounted Police Barracks .....	2,619 16			2,619 16
Edmonton Crown Lands Office, &c. ....	154 13			154 13
do Mounted Police Barracks .....		34 91		34 91
Fort Macleod Custom House .....		125 91		125 91
do Mounted Police Barracks .....		6,393 96		6,393 96
Fort Saskatchewan do .....		3,012 09		3,012 09
Indian Head Experimental Farm .....	1,601 97			1,601 97
Lethbridge Hospital .....		32 75		32 75
do Mounted Police Barracks .....		2,584 82		2,584 82
Maple Creek do do .....		3,885 06		3,885 06
Medicine Hat Hospital Govt. Grant .....	3,000 00			3,000 00
do Mounted Police Barracks .....		11 20		11 20
Milk River do do .....		15 83		15 83
Moose Jaw Court House .....	300 00			300 00
Mossomin do .....	9,461 71			9,461 71
do Mounted Police Barracks .....		27 00		27 00
do Post Office .....		6 00		6 00
Mounted Police Barracks—Fire extinguishers. ....	654 00			654 00
North Alberta Registry Office .....		16 00		16 00
Pendant d'Orville Mounted Police Barracks .....		19 60		19 60
Pincher Creek do do .....		212 42		212 42
Prince Albert Court House .....	2,084 68	40 50		2,125 18
do Crown Lands Office .....	177 26			177 26
do Mounted Police Barracks .....		904 00		904 00
do Registrar's Office .....		34 00		34 00
Public Buildings generally .....			3,161 58	3,161 58
Qu'Appelle Court House .....		67 70		67 70
do Immigrant Building .....		593 20		593 20
Red Deer Industrial School .....		60 64		60 64
Regina Clerk of Work's Office .....		834 03		834 03
do Court House .....		886 21		886 21
do do Gaol, water supply, fittings, &c. ....	9,750 92			9,750 92
do Crown Lands Office .....	195 60	267 85		463 45
do Immigrant Building .....		132 00		132 00
do Industrial School .....	10,320 65			10,320 65
do Gaol, Cottages for Officers .....	4,940 70			4,940 70
do Gaol and Lunatic Asylum .....		15 75		15 75
do Lieut.-Governor's new Residence .....	21,067 97			21,067 97
do do old do .....		607 85		607 85
do Mounted Police Barracks .....		7,964 47		7,964 47
do North-West Council Chamber .....	6,375 08			6,375 08
do Post Office .....		106 62		106 62
do Riding Hall .....		8 00		8 00
Stand Off Mounted Police Barracks .....		1,689 90		1,689 90
St. Mary's do do .....		85 83		85 83
Touchwood do do .....		70 00		70 00
Whitewood Immigrant Building .....		134 50		134 50
Wood Mountain Mounted Police Barracks .....		75 94		75 94
Writing-on-Stone do do .....		6 10		6 10
Carried forward.....	528,510 16	246,731 93	142,985 04	918,237 13



## APPENDIX No. 1.—Continued.

Name of Work.				Con- struction and Improve- ments.	Repairs.	Staff and Main- tenance.	Totals.
PUBLIC BUILDINGS—Continued.				\$ cts.	\$ cts.	\$ cts.	\$ cts.
Brought forward .....				578,358 31	249,931 50	142,995 04	971,284 85
EXPENDITURE ON ACCOUNT SERVICES MENTIONED.	Salaries of Engineers &c.	Supplies for En- gineers, &c.	Heating.	Lighting.	Water.	Totals.	
	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	
<i>Nova Scotia.</i>							
Aulherst Post Office .....	400 00	15 40	259 50	221 42		896 32	
Annapolis do .....	115 00		74 21		33 34	222 55	
Antigonish do .....	409 35	0 82	97 02	0 82		508 01	
Arichat do .....	15 00		84 00			99 00	
Baddeck do .....	200 00		108 00	12 88		320 88	
Halifax Appraiser's Office do Dominion Build- ings .....				9 20		9 20	
Halifax Examining Ware- house .....	2,067 96	72 35	912 59	3,047 10	325 00	6,425 00	
Halifax Immigrant Build- ing .....	500 00		249 38	51 40	91 00	891 78	
New Glasgow Post Office .....			116 92	214 80		331 72	
North Sydney do .....	400 00	13 77	145 00	243 47	100 00	902 24	
Pictou Marine Hospital do Post Office .....	433 33	10 95	166 00	23 21		633 49	
South Sydney Post Office .....			112 56			112 56	
Truro do .....	400 00		149 15	26 91		576 06	
Windsor do .....			106 00			100 00	
Yarmouth do .....	400 00	4 03	136 00	279 41	30 00	849 44	
	400 00		224 88	94 00	50 00	768 88	
	400 00	11 36	210 00	328 15	72 60	1,021 51	
<i>Prince Edward Island.</i>							
Charlottetown Dominion Building .....	1,814 21	31 45	557 61	1,188 87	168 75	3,760 89	
Montague Post Office .....	120 00	9 95	71 50	26 00		227 45	
Summerside do .....	400 00	13 54	219 86	42 84		676 24	
<i>New Brunswick.</i>							
Bathurst Post Office .....	400 00	10 74	454 00	40 75		905 49	
Carleton (St. John) Post Office .....	100 00		34 47	118 75	12 00	265 22	
Chatham Post Office .....	130 00		118 34	63 00		311 34	
Dalhousie do .....	233 31	24 98	190 00	11 05		459 34	
Fredericton do .....	400 00	4 10	324 05	441 18	30 00	1,199 33	
Moncton do .....	400 00	13 75	197 82	538 09	167 50	1,317 16	
Newcastle do .....	400 00	66 45	358 41	276 00		1,100 86	
Portland do .....			30 07			30 07	
St. John Custom House .....	1,820 04	35 11	1,447 40	133 34	686 70	4,122 59	
do Marine Hospital .....		1 45	598 30	266 70	46 89	913 34	
do Penitentiary .....	450 00		49 40	6 25		505 65	
do Post Office .....	1,205 00	50 54	607 95	2,149 59	564 48	4,577 56	
do Savings Bank .....			255 43	75 61	17 02	348 06	
St. Stephens Post Office .....	400 00		132 50	501 60	69 00	1,103 10	
Sussex do .....	400 00	0 66	158 19	11 75		570 60	
Woodstock do .....	433 30		194 75	160 00	34 00	822 05	
Carried forward .....	15,246 50	391 40	9,145 26	10,604 14	2,497 68	37,884 98	971,284 85

## APPENDIX No. 17. PLATES.

[illegible]

## APPENDIX No. 1—Continued.

Name of Work.		Construction and Improvements.		Repairs.	Staff and Maintenance.	Totals.
		\$ cts.		\$ cts.	\$ cts.	\$ cts.
PUBLIC BUILDINGS—Continued.		\$ cts.		\$ cts.	\$ cts.	\$ cts.
Brought forward.....		578,358 31		249,931 50	142,995 04	971,284 85
EXPENDITURE ON ACCOUNT SERVICES MENTIONED—Con.	Salaries of Engineers &c.	Supplies for Engineers, &c.	Heating.	Lighting.	Water.	Total.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.
Ontario—Concluded.						
Brought forward.....	32,148 55	829 55	23,883 70	22,731 77	6,921 55	86,515 12
Gananoque Post Office.....	100 00		76 00	211 50		387 50
Goderich do.....	400 00	49 28	212 50	39 56		701 34
Geolph do.....	400 00	38 01	210 09	236 80	28 08	912 98
Hamilton Custom House.....	600 00			134 30		734 30
do Drill Hall.....	360 00					360 00
do Post Office.....	1,022 50	7 53	1,010 00	1,523 40	1,000 00	4,563 43
Kingston Custom House.....	46 80		186 00	103 80	76 80	413 40
do Examining Warehouse.....					6 00	6 00
do Inland Revenue Office.....				52 40	157 72	210 12
do Military College.....	1,468 00					1,468 00
do Post Office.....	125 74	21 00	76 13	421 40	56 26	700 53
Lindsay do.....	400 00	1 50	99 36	112 44		613 30
London Custom House.....	1,000 00	19 30	574 56	301 85	105 00	2,000 71
do Post Office.....	600 00	7 75	592 12	613 40	60 00	1,873 27
Napanee do.....	400 00	18 45	154 00	103 80	77 23	753 48
Niagara Falls Post Office.....	400 00	44 58	258 75	75 46	12 50	791 29
Orangeville do.....	400 00	11 90	173 19	145 98		731 07
Ottawa Experimental Farm.....			246 75	143 46		390 21
do Langevin Block.....	5,848 57	65 13				5,913 70
do Post Office.....				258 45		258 45
Pembroke Post Office.....	254 42	10 65	329 66	82 00		676 73
Peterboro do.....	400 00		143 92	321 45	75 00	940 37
Port Arthur do.....			17 50			17 50
Port Colborne do.....	240 00	34 94	156 25	27 30		458 49
Port Hope do.....	400 00	18 55	223 50	164 00		806 05
Prescott do.....	196 65	24 63	220 85	7 00		449 13
do Custom House.....			131 25			131 25
St. Catharines Post Office.....	400 00	14 33	252 96	160 60	57 00	884 89
St. Thomas do.....	400 00	28 29	348 60	374 10	40 83	1,191 82
Stratford do.....	600 00	21 00	362 12	358 00	63 00	1,404 12
Strathroy do.....	283 30	24 02	192 29	13 47		513 08
Toronto Assist. Receiver General's Office.....				100 35		100 35
Toronto Custom House.....	640 00	12 15	413 74	107 00	230 57	1,403 46
do Dominion Buildings.....					884 82	884 82
do Examining Warehouse.....	5,509 35	36 87	805 36	30 84	112 00	6,584 42
do Inland Revenue Office.....	5 36	2 50	262 33	195 76	199 11	665 06
do Post Office.....	1,131 50	10 68	720 34	1,121 11	325 59	3,309 22
Trenton do.....	400 00	4 00	125 00	343 00		872 00
Windsor do.....	1,000 00	3 00	453 50	698 71	82 20	2,237 41
Carried forward.....	57,670 74	1,359 59	32,912 32	31,314 46	10,571 26	138,828 37
						971,284 85

## APPENDIX No. 1—Continued.

Name of Work.	Construction and Improvements.		Repairs.		Staff and Maintenance.		Total.	
	\$	cts.	\$	cts.	\$	cts.	\$	cts.
<b>PUBLIC BUILDINGS—Continued.</b>								
Brought forward	578,358	31	249,931	50	142,985	04	971,284	85
EXPENDITURE ON ACCOUNT SERVICES MENTIONED— <i>Con.</i>	Salaries of Engineers, &c.	Supplies for Engineers, &c.	Heating.	Lighting.	Water.	Total.		
	\$	cts.	\$	cts.	\$	cts.	\$	cts.
<i>Manitoba.</i>								
Brought forward.	57,670	74	1,369	59	32,912	32	31,314	46
Brandon Experimental Farm.			58	38				58 38
do Post Office.	100	00						100 00
Deloraine Dominion Lands Office.			51	00				51 00
Minnedosa Dominion Lands Office.			110	00				110 00
Souris Dom. Lands Office.			56	01				56 01
Winnipeg Custom House.		15	542	50	225	45	43	25 15
do Dominion Lands Office.			231	25	20	79		252 04
do Examining Warehouse.			483	00	9	72		592 72
do Immigrant Shed.			123	25	100	33	31	25 83
do Indian Office.			123	00				123 00
do Intelligence Office.			18	50				18 50
do Post Office.	1,448	75	73	38	2,373	00	1,109	16
Stony Mountain Penitentiary.			40	00				40 00
<i>North-West Territories.</i>								
Battleford Domin. Lands Office.			52	50				52 50
do Registry Office.			65	45				65 45
Birtle Dominion Lands Office.			75	00				75 00
Calgary Barracks.					1,500	00		1,500 00
do Clerk of Works Office.			40	00				40 00
do Court House.		51	820	00	70	00		941 00
do Dom. Lands Office.			248	55				248 55
do Immigrant Building.			64	00				64 00
do Mines Office.			220	10				220 10
do Registry Office.			110	50				110 50
Cannington Manor Dom. Lands Office.			45	00				45 00
Edmonton Crown Lands Office, &c.			21	50				21 50
do Dom. Lands Office.			18	25				18 25
do Registry Office.			27	00				27 00
Fort Macleod Custom House.			201	50				201 50
Indian Head Experimental Farm.			237	35				237 35
Carried forward.	60,650	49	1,988	97	39,378	91	34,349	91

971,284 85

## APPENDIX No. 1—Continued.

Name of Work.				Con- struction and Improve- ments.	Repairs.	Staff and Main- tenance.	Total.
PUBLIC BUILDINGS—Concluded.				\$ cts.	\$ cts.	\$ cts.	\$ cts.
Brought forward .....				578,358 31	249,931 50	142,995 04	971,284 85
EXPENDITURE ON ACCOUNT SERVICES MENTIONED—Con.	Salaries of Engineers, &c.	Supplies for En- gineers, &c.	Heating.	Lighting.	Water.	Total.	
North-West Territories— Concluded.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	
Brought forward.....	60,659 49	1,498 97	39,378 91	34,349 91	11,238 91	147,126 19	
Leithbridge Dom. Lands Office .....			25 50			25 50	
Medicine Hat Intelligence Office .....			23 50			23 50	
Meosomin Court House .....	152 37		55 77			208 14	
Prince Albert Court House .....	400 00	11 00	186 00	22 60		619 60	
do Dom. Lands Office .....			50 50			50 50	
do Registry Office .....			76 00			76 00	
Qu'Appelle Dom. Lands Office .....			29 37			29 37	
do Immigrant Building .....			7 00			7 00	
Red Deer Dominion Lands Office .....			4 00			4 00	
Regina Court House .....	142 00	81 58	509 66	3 36	15 65	752 25	
do Dominion Lands Office .....			174 00			174 00	
do Gaol and Lunatic Asylum .....	861 66	290 22	838 68	18 93		2,009 49	
do Lieut. Governor's Residence .....	300 00		871 03			1,171 03	
do Post Office .....			273 87			273 87	
Touchwood Dom. Lands Office .....			6 25			6 25	
<i>British Columbia.</i>							
Kamloops Dom. Lands Office .....			4 75			4 75	
Nanaimo Post Office .....	600 00		20 00	226 20	36 00	882 20	
New Westminster Fisher- ies Office .....			3 50			3 50	
New Westminster Post Office .....	600 00		131 25	181 50		912 75	
Victoria Appraiser's Office .....					6 50	6 50	
do Custom House .....			192 24	35 85	119 84	347 93	
do Post Office .....			213 15	906 99	46 24	1,166 38	
Dominion Buildings .....			3,767 04			3,767 04	
Ottawa do .....	98 00					98 00	
Totals .....	63,813 52	1,881 77	46,841 97	35,745 34	11,463 14		159,745 74
Carried forward .....				578,358 31	249,931 50	302,740 78	1,131,030 59

## APPENDIX No. 1—Continued.

Name of Work.	Con- struction and Improve- ments.	Repairs.	Staff and Main- tenance.	Total.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.
Brought forward.	578,354 31	249,981 50	302,740 78	1,131,030 59
<b>HARBOURS AND BREAKWATERS.</b>				
<i>New Scotia.</i>				
Arsenic Pier	685 00			685 00
Barrington Passage Pier	3,199 32			3,199 32
Beale Cove		626 57		626 57
Broad Cove		216 47		216 47
Caribou	981 22			981 22
Cheticamp	2,185 76			2,185 76
Church Point		100 81		100 81
Cow Bay Breakwater		3,499 98		3,499 98
Gribbin's Point—Wharf	2,405 40			2,405 40
Delap's Cove Pier		24 49		24 49
Digby—New Pier at the Raquette		2,388 02		2,388 02
do old Pier		111 56		111 56
Economy Breakwater	2,199 92			2,199 92
French River Pier	95 17			95 17
Great Village	290 81			290 81
Georgetown Wharf	971 07			971 07
Halifax Graving Dock—Subsidy	10,000 00			10,000 00
Hampton Pier		21 00		21 00
Harbours Generally			4,949 48	4,949 48
Harbourville Pier		150 13		150 13
Ingonish (North)	722 89			722 89
Irish Cove	1,993 65			1,993 65
Joggins Breakwater		2,184 56		2,184 56
Jordan Bay Breakwater		30 03		30 03
Kemington Cove (Galarvona)		800 00		800 00
L'Anse-au-Loup Breakwater	74 57			74 57
Lismore—Extension of Pier	2,068 06			2,068 06
Little Brook		100 00		100 00
Louis Head	76 64			76 64
Mahon	3,730 14			3,730 14
Margaree	2,169 09			2,169 09
Margaretville		398 67		398 67
Merigomish		50 00		50 00
Meteghan River Pier		265 19		265 19
Moldart Pier	590 28			590 28
Ogilvy's Wharf		125 00		125 00
McNair's Cove		349 99		349 99
Parrish's Pier		48 79		48 79
Porter's Lake Pier		200 00		200 00
Port George Pier	5,137 16			5,137 16
Port Hood Pier	5,424 92			5,424 92
Port Labour Pier		2,999 92		2,999 92
Port Maitland or Green Cove	5,839 92			5,839 92
River Southwest (improvement) to channel, St. Mary's Bay to Weymouth)	1,968 84			1,968 84
Round Hill	74 59			74 59
Sand River	86 92			86 92
Sheet Harbour		150 00		150 00
Stony Island	1,126 07			1,126 07
South Gut, St. Ann's	1,518 91			1,518 91
Semmerville Pier (Hart's Co.)		1,051 69		1,051 69
Tidnish	2,111 53			2,111 53
Victoria Pier		74 98		74 98
Walton	1,515 05			1,515 05
Carried forward	637,601 21	265,899 35	307,690 26	1,211,190 82

## APPENDIX No. 1—Continued.

Name of Work.	Con- struction and Improve- ments.	Repairs.	Staff and Main- tenance.	Total.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.
Brought forward. ....	637,601 21	265,899 35	307,690 26	1,211,190 82
<b>HARBOURS AND BREAKWATERS—Con.</b>				
<i>Nova Scotia—Concluded.</i>				
West Chezzetcook. ....	168 87			168 87
Wreck Cove. ....	700 99			700 99
Yarmouth. ....		1,441 49		1,441 49
<i>Prince Edward Island.</i>				
Annandale Pier. ....		85 00		85 00
Bay View Pier. ....		364 69		364 69
Belfast Pier. ....		396 77		396 77
Bras Harbour Breakwater. ....	56 06			56 06
Campbell's Cove Breakwater. ....		129 82		129 82
Cascumpec Harbour. ....	772 87			772 87
Chapel Point Pier. ....		372 62		372 62
China do. ....		1,224 12		1,224 12
Georgetown Pier. ....		200 00		200 00
Harbours generally. ....			1,562 41	1,562 41
Hickey's Pier. ....		249 97		249 97
Hurd's Point Pier. ....		118 24		118 24
Kier's Shore Pier. ....		199 99		199 99
Malpeque Breakwater. ....		247 14		247 14
Miminegash do. ....		550 71		550 71
New London do. ....		393 50		393 50
North Cardigan Pier. ....		76 63		76 63
Pinette Pier. ....		198 71		198 71
Port Selkirk Pier. ....	548 54			548 54
Pownal Pier. ....		28 60		28 60
Red Point Pier. ....		700 69		700 69
Rustico--North Breakwater. ....	\$912 48			939 36
do South do. ....	26 88	939 36		939 36
Souris East—Knight's Point Pier. ....		3,699 82		3,699 82
Stevens' Pier. ....		199 96		199 96
St. Mary's Bay Pier. ....		349 99		349 99
Sturgeon Pier. ....		87 50		87 50
Victoria. ....		613 81		613 81
<i>New Brunswick.</i>				
Campbellton Ballast Wharf. ....	2,032 82			2,032 82
Cape Tormentine Harbour. ....	48,308 96			48,308 96
Carraquet Harbour. ....	433 72			433 72
Edgett's Landing. ....	2,832 65			2,832 65
Gray's Island Breakwater. ....	1,122 25			1,122 25
Harbours generally. ....			4,949 47	4,949 47
Kingston Wharf, Richibucto River. ....	1,912 82			1,912 82
Oronecto Shoals Shear Dam, repairs. ....		499 85		499 85
Richibucto Harbour. ....	1,487 48			1,487 48
River St. John, Fredericton to Woodstock. ....	1,499 82			1,499 82
do River des Chutes do. ....	452 56			452 56
River Tobique. ....	300 00			300 00
St. John Harbour, Negro Point Breakwater. ....	4,688 22			4,688 22
Shediac Harbour. ....	2,837 55			2,837 55
Shippagan Harbour. ....	8,065 57			8,065 57
Carried forward. ....	715,852 96	279,248 43	314,202 14	1,309,323 53

## APPENDIX No. 1—Continued.

Name of Work.	Con- struction and Improvements.	Repairs.	Staff and Main- tenance.	Total.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.
Brought forward.	715,852 96	279,268 43	314,202 14	1,309,323 53
<b>HARBOURS AND BREAKWATERS—Con.</b>				
<i>Quebec.</i>				
Aynes Pier, Lake Megantic		77 25		77 25
Anse à L'Eau or Tadoussac Pier		1,250 04		1,250 04
Anse St. Jean Pier		999 42		999 42
Basin St. Paul Pier	5,262 55			5,262 55
Beauport Pier	300 00			300 00
Bélair Pier	1,470 35	30 00	145 00	1,645 35
Berthier (en bas) Pier		531 86		531 86
Boucherville Pier	3,200 00			3,200 00
Cacouna Pier	3,663 68			3,663 68
Cap à l'Aigle Pier		20 00		20 00
Cap de la Madeleine Pier	1,000 00			1,000 00
Cedars Pier		264 41		264 41
Chicoutimi Pier		1,802 70		1,802 70
Coteau Landing Pier (reconstruction)		4,060 00		4,060 00
Étang du Nord	844 63			844 63
Gatineau River	1,506 96			1,506 96
Grande Rivière	11,001 25			11,001 25
Grosse Isle Quarantine Station Wharf		7,092 94		7,092 94
Harbours generally			8,337 08	8,337 08
Kamouraska Pier	893 83	741 36		1,635 19
Isle Verte Pier	2,994 67			2,994 67
Laprairie revetment wall	658 58			658 58
Les Éboulements Pier		62 48		62 48
Lewis Graving Dock	6,286 24		5,606 31	11,891 55
Longueuil Pier	9,592 91			9,592 91
Londres Pier (Lake Megantic)		500 00		500 00
Malbaie Pier		40 52		40 52
Montreal Harbour			1,335 60	1,335 60
do Flood Commission	1,681 00			1,681 00
New Carlisle Pier	5,688 87			5,688 87
Newport River	450 00			450 00
Piers below Quebec			12,520 19	12,520 19
Ponts à Valons Wharf extension	1,877 09			1,877 09
Ponts St. Pierre removal of reef	1,500 00			1,500 00
Port Daniel Pier	8,126 21			8,126 21
Rimouski Pier	9,993 83			9,993 83
Rivière Beaudet	198 45			198 45
do Champlain	200 00			200 00
do des Prairies improvements at Pt. à la Carrière	4,931 04			4,931 04
do du Lièvre	40,019 14			40,019 14
do du Loup (en bas)	740 40	440 95		1,181 35
do L'Assomption	899 23			899 23
do McKinnac	497 73			497 73
do Nicolet harbour of refuge	5,162 74			5,162 74
do Ottawa channel at Mille Isles	975 37			975 37
do Onelle Pier		1,494 28		1,494 28
do St. François	4,011 05			4,011 05
do St. Lawrence ship channel between Gaspe and Montreal	121,342 02			121,342 02
do St. Louis	4,501 31			4,501 31
do St. Maurice west channel	1,500 00			1,500 00
do Yamaska		9,202 87	1,297 01	10,499 88
Sorel ice piers	1,696 25			1,696 25
St. Alphonse (Baguetteville) Pier		1,000 80		1,000 80
Ste. Anne de la Pêrade dredging	2,597 73			2,597 73
Carried forward	983,118 07	308,880 41	343,442 33	1,635,440 81

APPENDIX No. 1 *Continued.*

Name of Work.	Con- struction and Improve- ments.	Repairs.	Staff and Main- tenance.	Total.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.
Brought forward. ....	983,118 07	308,880 41	343,442 33	1,635,440 81
<b>HARBOURS AND BREAKWATERS—Continued.</b>				
<i>Quebec Concluded.</i>				
Ste. Anne des Monts Pier. ....	5,000 00			5,000 00
Ste. Anne du Saguenay Pier. ....	2,498 96			2,498 96
St. Anicet Pier. ....		635 10		635 10
St. Famille Pier. ....		999 30		999 30
St. François, Isle d'Orleans. ....		748 09		748 09
St. Jean. ....		500 82		500 82
St. Laurent. ....	6,263 56			6,263 56
St. Michel de Bellechasse Pier. ....		999 89		999 89
St. Siméon Pier. ....	4,555 00			4,555 00
St. Timothée Pier. ....	998 47			998 47
Three Rivers Pier. ....	7,081 30			7,081 30
do Harbour. ....	746 98			746 98
Trois Pistoles Pier. ....	2,989 45			2,989 45
<i>Ontario.</i>				
Beaverton Harbour. ....	6,475 46			6,475 46
Belleville Harbour Works. ....	100 00			100 00
do Dredging. ....	6,473 37			6,473 37
Big Bay, North Keppel. ....		2,065 00		2,065 00
Burlington Bay Channel. ....			702 04	702 04
Cobourg Harbour. ....		4,002 57		4,002 57
Georgian Bay—Removal Robertson rocks. ....	1,528 03			1,528 03
Goderich Harbour. ....		600 00		600 00
Harbours Generally. ....			11,083 79	11,083 79
Kaministiquia River. ....	25,201 76			25,201 76
Kincardine Harbour. ....		1,549 82		1,549 82
Kingston Graving Dock. ....	219,646 53			219,646 53
do Harbour. ....	5,948 00			5,948 00
Kingville do. ....		747 68		747 68
Little Current, Lake Huron. ....	5,390 81			5,390 81
Little Nation River. ....	5,500 00			5,500 00
Meaford Harbour. ....	3,286 13			3,286 13
Midland do. ....	7,721 08			7,721 08
Oakville do. ....	958 49			958 49
Otonabee River. ....	1,330 01			1,330 01
Owen Sound Harbour. ....	30,459 60			30,459 60
do do dredging entrance channel. ....	589 38			589 38
Parry Sound Narrows. ....	4,320 44			4,320 44
Penetanguishene. ....	4,671 82			4,671 82
Port Arthur Harbour. ....	36,990 38			36,990 38
do Elgin do. ....		1,000 00		1,000 00
do Hope do. ....		2,948 30		2,948 30
Portsmouth do. ....		1,091 81		1,091 81
Rideau River, dredging North Branch. ....	2,657 55			2,657 55
River Ottawa, Narrows above Pembroke. ....	1,516 25			1,516 25
Rideau Harbour. ....		2,000 00		2,000 00
Saugen River. ....	1,600 00			1,600 00
Southampton Harbour. ....	5,966 20			5,966 20
Sydenham River. ....	3,008 60			3,008 60
Toronto Harbour. ....	95,009 35			95,009 35
Warton Breakwater. ....	8,777 44			8,777 44
Carried forward. ....	1,498,378 47	328,768 79	355,178 16	2,182,325 42

APPENDIX No. 1—*Continued.*

Name of Work.	Con- struction and Impro- vements.	Repairs.	Staff and Main- tenance.	Total
	\$ cts.	\$ cts.	\$ cts.	\$ cts.
Brought forward.	1,498,378 47	328,768 79	355,178 16	2,182,325 42
<b>HARBOURS AND BREAKWATERS—<i>Continued.</i></b>				
<i>Manitoba.</i>				
Harbours Generally.			4,037 79	4,037 79
Red River, Survey.			1,334 81	1,334 81
<i>North-West Territories.</i>				
Harbours Generally.			3,223 81	3,223 81
Waseana Dam.		133 74		133 74
<i>British Columbia.</i>				
Columbia River, above Golden.	4,989 97			4,989 97
do between Revelstoke and Arrow Lake.	5,941 43			5,941 43
do mouth of Kootenay River and Boundary line.	5,417 99			5,417 99
Coquitlam River.	499 87			499 87
Cowichan River.	1,000 36			1,000 36
Esquimalt Graving Dock.	2,639 65		12,725 90	15,365 55
Fraser River.	21,162 47			21,162 47
Harbours Generally.			1,272 45	1,272 45
Nanaimo Harbour, Removal of Nicol rock.	4,982 61			4,982 61
New Westminster Wharf.		783 97		783 97
Nicomexkel River.	503 00			503 00
Skeena River.	1,255 33			1,255 33
Victoria Harbour.	6,032 51			6,032 51
<b>HARBOURS GENERALLY.</b>			9,399 96	9,399 96
Dredges, repairs.		28,659 42		28,659 42
Dredging Plant, Maritime Provinces.	\$ 4,590 75			
do Quebec and Ontario.	5,999 91			
do British Columbia.	4,714 70			
		15,305 36		15,305 36
<b>DREDGING.</b>				
<i>Nova Scotia.</i>				
Cheticamp.	\$1,360 43			
Malton Harbour.	5,117 16			
Pictou, Dwyer's Wharf.	178 08			
do Market.	6,610 06			
Tatamagouche.	2,967 70			
Tracadie.	1,940 20			
				\$18,173 63
<i>Prince Edward Island.</i>				
Casempee.	\$ 467 24			
Gauthier's Creek.	7,208 48			
		\$ 7,675 72		
Carried forward.	\$ 25,849 35	1,568,100 02	358,345 92	387,172 4
				2,313,627 42

## APPENDIX No. 1—Continued.

Name of Work.	Construction and Improvements.	Repairs.	Staff and Maintenance.	Total.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.
Brought forward . . . . .	\$25,849 35	1,568,109 02	358,345 92	387,172 88
<b>DREDGING—Concluded.</b>				
<i>New Brunswick.</i>				
Hampton . . . . .	\$1,092 97			
Lamb's Point . . . . .	2,671 26			
Perry's Point . . . . .	3,148 43			
Richibucto . . . . .	811 10			
	\$ 7,723 76			
Generally (printing) . . . . .	26 29			
Total Maritime Provinces . . . . .	\$33,599 40			
<i>Quebec.</i>				
Beauharnois . . . . .	\$1,032 88			
Lachine . . . . .	836 65			
Lake of Two Mountains . . . . .	2,749 19			
Ottawa River, Shoals, &c. . . . .	924 15			
River Nicolet . . . . .	2,867 50			
River Yamaska . . . . .	4,725 67			
St. Anne de la Perade . . . . .	3,946 50			
St. Placide, Ottawa River . . . . .	416 73			
St. Maurice, West Channel . . . . .	500 00			
GENERAL . . . . .	2,678 15			
	\$20,677 42			
<i>Ontario.</i>				
Bowmanville . . . . .	\$ 285 00			
Goderich . . . . .	99 00			
Kincardine . . . . .	1,002 13			
Newcastle . . . . .	185 00			
Otonabee River . . . . .	953 40			
Ottawa River . . . . .	2,232 29			
Pickering . . . . .	484 38			
Point Edward . . . . .	6,237 10			
Port Albert . . . . .	1,168 33			
Port Hope . . . . .	48 00			
Rideau River, North Branch . . . . .	188 00			
Shannonville . . . . .	1,156 64			
Trenton . . . . .	2,993 69			
Whitby . . . . .	625 64			
Generally . . . . .	5,016 65			
	\$22,675 25			
<i>Manitoba.</i>				
Red River . . . . .	9,716 61			
White Mud River . . . . .	5,284 93			
	15,001 54			
<i>British Columbia.</i>				
Fraser River . . . . .	4,709 83			
Victoria Harbour . . . . .	9,975 83			
	14,685 66			
GENERAL SERVICE . . . . .	2,888 93			
	109,528 20			
Carried forward . . . . .	1,677,637 22	358,345 92	387,172 88	2,423,156 02

## APPENDIX No. 1—Continued.

Name of Work.	Con- struction and Improve- ments.	Repairs.	Staff and Main- tenance.	Total.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.
Brought forward .....	1,677,637 22	358,345 92	387,172 88	2,423,156 02
SLIDES AND BOOMS.				
Saguenay District .....	774 21	2,247 23	1,080 56	4,102 00
St. Maurice District .....		6,638 78	17,155 67	23,794 45
Ottawa District .....			24,900 35	24,900 35
Ottawa River, Mountain slide .....	\$9,575 42	1,061 79		1,061 79
Ottawa River, reconst'n slide Calumet Falls .....	9,050 41			9,050 41
Ottawa River, reconstruction works Des Joachim, &c. ....	4,797 81			4,797 81
Madawaska River, new pier, &c., Little Rapids .....	2,939 54	333 74		333 74
Petowawa River .....	4,089 53	4,995 13		4,995 13
Black River .....	240 71			
Coulonge River .....	308 00			
Dumoine River .....	1,628 00			
Gatineau .....	2,452 09			
Newcastle .....		21,233 29		21,233 29
		1,207 71	2,100 22	3,307 93
COLLECTION OF SLIDE AND BOOM DUES.				
St. Maurice District .....	\$1,257 32			
Ottawa District .....	4,404 01			
Newcastle District .....	190 58			
			5,851 91	5,851 91
ROADS AND BRIDGES.				
<i>Ontario.</i>				
Ottawa Bridges, &c. --				
Cartier Square .....	\$ 505 08			
Chaudière Bridge .....	2,392 83			
do New Iron Truss Bridge .....	2 50			
do Bridge Lighting .....			100 00	100 00
Dufferin Bridge .....	33 55			
Maria Street Old Bridge .....	29 96			
do New do .....		1,622 70		1,622 70
Nepean Point .....	84 00			
Wellington Street .....	5,470 49			
York Bridge, over Grand River .....		17,829 65		17,829 65
			8,518 41	8,518 41
				17,829 65
<i>North-West Territories.</i>				
Battleford Bridge, over Battle River .....	9,204 30			9,204 30
Belly River Bridge, Lethbridge .....	16,753 21			16,753 21
Bow do .....	40 00			40 00
Old Man's River Bridge, Fort Macleod .....	2,417 88			2,417 88
TELEGRAPH LINES.				
<i>Nova Scotia.</i>				
Cape Sable .....	\$ 224 73			
Cheticamp .....	598 81			
Low Point .....	50 00			
Meat Cove .....	1,555 81			
	2,429 35	3,012 00		3,012 00
Carried forward .....	\$ 2,429 35	1,749,530 05	389,672 93	446,880 00
				2,586,082 98

APPENDIX No. 1—*Concluded.*

Name of Work.	Con- struction and Improve- ments.	Repairs.	Staff and Main- tenance.	Total.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.
Brought forward.....	\$ 2,429 35	1,749,590 05	389,672 93	446,880 00
2,586,082 98				
<b>TELEGRAPH LINES—<i>Concluded.</i></b>				
<i>Prince Edward Island.</i>				
Prince Edward Island and Mainland Subsidy ..			1,946 66	1,946 66
<i>New Brunswick.</i>				
Bay of Fundy.....	\$ 1,212 91			
Ecuminac .....	434 02			
Grand Manan and Whitehead Island .....	1,136 57	2,783 50		2,509 53
<i>Quebec.</i>				
Anticosti Island—North Shore Cable .....	\$ 2,433 94	14,376 79		14,376 79
Grosse Isle Quar. Station .....	493 92			
Magdalen Islands .....	2,117 09			
North Shore Towards Pt. aux Esquimaux .....		2,301 13		2,301 13
do East Bersimis .....	4,013 81			
do West do .....	3,171 20			
	12,229 96			
GENERALLY .....	11,677 57			
Total Telegraph Lines, Lower St. Lawrence.			29,120 38	29,120 38
<i>Ontario.</i>				
Pelee Island.....	69 83		217 66	287 49
<i>North-West Territories.</i>				
Telegraph lines generally.....	87 40		22,389 14	22,476 54
<i>British Columbia.</i>				
Ashcroft and Barkerville—Reconstruction.....	12,917 99		5,334 65	18,252 64
Bonilla Point and Cape Beale to Victoria.....	3,152 95			3,152 95
TELEGRAPH SERVICE GENERALLY .....			9,460 61	9,460 61
<b>MISCELLANEOUS.</b>				
Agent and contingencies, British Columbia.....			5,297 98	5,297 98
Surveys and Inspections.....			15,752 30	15,752 30
do and Plans of Government properties .....			294 00	294 00
Extra Clerks preparing returns ordered by Parliament .....			109 00	109 00
Totals.....	1,784,945 67	389,672 93	536,802 38	2,711,420 98
<b>WORKS AUTHORIZED BY SPECIAL ACTS OF PARLIAMENT.</b>				
Quebec Harbour Improvements .....	50,600 00			50,600 00
Grand Totals.....	1,835,545 67	389,672 93	536,802 38	2,762,020 98

DEPARTMENT OF PUBLIC WORKS,  
OTTAWA, 5th February, 1892.

O. DIONNE,  
Accountant.



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**APPENDIX No. 2.**

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**REPORT**

**ON**

**PUBLIC BUILDINGS**

**THROUGHOUT THE DOMINION,**

**FOR THE FISCAL YEAR ENDED 30<sup>TH</sup> JUNE, 1891.**

**BY**

**THE CHIEF ARCHITECT.**

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## APPENDIX No. 2.

### REPORT OF THE CHIEF ARCHITECT.

DEPARTMENT OF PUBLIC WORKS, CANADA,  
CHIEF ARCHITECT'S OFFICE,  
OTTAWA, 11th January, 1892.

SIR,—I have the honour herewith to transmit report of the various works performed under my charge, during the fiscal year ended the 30th June, 1891.

I have the honour to be, Sir,

Your obedient servant,

THOMAS FULLER,  
*Chief Architect.*

E. F. E. Roy, Esq.,  
Secretary, Department of Public Works.

### PROVINCE OF NOVA SCOTIA.

#### ANNAPOLIS.

##### POST OFFICE, &C., BUILDING.

This building which was described in my report for 1889-90 has been completed, fitted up, furnished, supplied with a hot water heating apparatus and occupied.

Plans, &c., prepared and work superintended by this Department.

Clerk of works, Mr. Chas. Jacques.

Contractors for building and fittings, Messrs. Rhodes, Curry & Co., Amherst, N.S.

Contractors for the heating apparatus, Messrs. Garth & Co., Montreal, P.Q.

#### ANTIGONISH.

##### PUBLIC BUILDING.

Sundry necessary repairs were made and the outside of the building repainted.

Clerk of works, Mr. John E. Turnbull.

#### DARTMOUTH.

##### PUBLIC BUILDING.

Negotiations for the purchase of a site are in progress.

#### HALIFAX.

##### DOMINION BUILDING.

A granolithic sidewalk was laid completely around the building.

Repairs were made to the heating boiler, the plumbing, basement ceiling and floor, roofs and eavestroughs, the drains were cleaned, the incandescent electric light was installed throughout the ground floor. The Marine and Fisheries offices were repaired, painted, renovated and carpeted. The Post Office Inspector's office was carpeted and the furniture repaired.

Clerk of works, Mr. John E. Turnbull.

**EXAMINING WAREHOUSE.**

Changes and improvements were made to the heating apparatus. The gauger's office was added to and improved, and the roof was repaired.

Clerk of works, Mr. John E. Turnbull.

**IMMIGRATION BUILDING.**

This building which was described in my report of last year is completed, fitted up, furnished with electric light and occupied.

Plans, &c., prepared and work superintended by J. C. Dumaresq, architect, Halifax, N.S.

Clerk of works, Mr. D. Grant.

**NAPPAN.****EXPERIMENTAL FARM BUILDINGS.**

Since the date of my last report the plumbing consisting of the w. c.'s, sinks, &c., have been supplied to the superintendent's residence, under the supervision of this Department.

**NEW GLASGOW.****PUBLIC BUILDING.**

Some pointing of stonework and minor repairs have been executed. Incandescent electric lighting has been installed in the offices, and electric bells and speaking tubes put in where required.

Clerk of works, Mr. John E. Turnbull.

**PICTOU.****CUSTOM HOUSE.**

Repairs were made to walls and roof, and to the interior of the building and heating apparatus.

Clerk of works, Mr. John E. Turnbull.

**QUARANTINE STATION.**

The grounds were enclosed by a substantial fence, and a road made through the grounds from the highway to the hospital building.

Clerk of works, Mr. John E. Turnbull.

**SYDNEY.****POST OFFICE, &c., BUILDING.**

This building is completed and occupied.

Plans, &c., prepared and work supervised by this Department.

Clerk of works, Mr. T. E. Burchell, Sydney.

Contractors for the building, Messrs. Connor & Donald, Moncton.

Contractor for the fittings, Mr. Ronald Gillis.

Contractors for the heating apparatus, The Cape Breton Foundry Company.

**TRURO.****PUBLIC BUILDING.**

The pipe furnace being out of repair and unsuitable for the consumption of soft coal, was replaced by two sectional hot water furnaces. Repairs were made to brick-work; the savings bank office was supplied with additional fittings, and some internal repairs were made.

Clerk of works, Mr. John E. Turnbull.

**WINDSOR.****POST OFFICE BUILDING.**

Some repairs and pointing to outside and repairs to inside were executed. The ceilings were whitened, walls tinted and post office screen varnished. Clerk of works, Mr. John E. Turnbull.

**PROVINCE OF NEW BRUNSWICK.****BATHURST.****PUBLIC BUILDING.**

The drains were overhauled and the discharge end changed and protected from damage by ice or stoppage, the plumbing was improved and additional ventilation provided; storm sashes were provided for first floor.

Repairs were made to heating, pointing, and new glass dial for clock and fire buckets supplied.

**CARLETON.****POST OFFICE.**

Owing to the action of the spring tide, water entered the cellar and caused the settling of the filling and falling in of the concrete floor, the breaking of the terra-cotta drain pipes, and the destruction of the water closets. The sewer was relaid with 4-inch cast iron pipe; a new water closet was put in and a brick arched floor constructed.

A change in grade of street necessitated new granite steps to main entrance. Works carried out under the supervision of Mr. W. J. McCordock, C. E.

**DALHOUSIE.****POST OFFICE.**

A plentiful supply of water was obtained by two outside wells and an inside brick tank with pipe connections and pump; and all necessary plumbing, basins, sinks, &c., were furnished and connected with the water supply and drainage.

Works carried out under the supervision of Mr. Jno. E. Turnbull, clerk of works.

**CHATHAM.**

Minor damages produced by neighbouring fire were made good and minor repairs effected under the supervision of Mr. Jno. E. Turnbull, clerk of works.

**FREDERICTON.****POST OFFICE, &C., BUILDING.**

The hot air heating apparatus was removed and replaced by a hot water apparatus.

Plans, &c., prepared and work supervised by this Department.

Clerk of works, Mr. F. S. Hilyard.

Contractors for heating, Messrs. Garth & Co., Montreal.

**MONCTON.****POST OFFICE.**

The tubes of the furnace being completely worn out have been retubed with brass tubing, under the supervision of Mr. Jno. E. Turnbull, clerk of works.

## PARTRIDGE ISLAND (ST. JOHN).

### QUARANTINE STATION.

A new enclosure fence has been made around the grounds, the hospitals have been whitened, and, in part, painted, under the supervision of Mr. Jno. E. Turnbull, clerk of works.

### SACKVILLE.

#### PUBLIC BUILDING.

Negotiations for the purchase of a site are in progress.

### ST. JOHN.

#### CATTLE QUARANTINE.

Sheds and fences, in accordance with the requirements of the Department of Agriculture, were erected at the Old Penitentiary grounds for the cattle quarantine service.

#### CUSTOM HOUSE.

A new asphalt floor was laid in boiler room. The hoist was supplied with larger shafting, new mitre gear wheels, new platform and iron braces and repaired throughout. In the middle of the building the Customs Long Room, the rooms of landing surveyors, entering and clearance warehouse, gaugers and tide surveyors had woodwork set up, plastering repaired, ceilings cleaned and walls and woodwork cleaned and painted; and in the south wing the rooms of the Marine and Fisheries Agent, Inspector of lights, Master and Mates examination, and those of the Steamboat Inspector and Boiler Inspector treated in the same manner.

Repairs were made to signal mast, heating and plumbing, electric bells, locks, hinges and furniture.

Works executed under the supervision of Mr. W. J. McCordock.

#### MARINE HOSPITAL.

Repairs were made to sewer, galvanized iron roof, closets and urinals, water pipes, batteries, bells, &c. The gas metre was changed in position. Some new pipes were put in hot water heating furnace and a portion of the mains in basement covered with felt. The iron roofs, gutters, cornices, sashes and frames were painted and the front door varnished.

Work carried out under the supervision of Mr. W. J. McCordock, C.E.

#### POST OFFICE.

Ventilating pipes were provided from parcel post office to main ventilating shaft. The two inside porches of side doors were removed and an enlarged inside porch to main entrance provided. Ten water closets, obsolete pattern, were removed and replaced by others of improved pattern; new urinals on all flats arranged with acting flush tanks were put in, and the water supply to basins and drinking taps was taken directly from main supply pipe. The 9" terra-cotta main sewer pipe and 6" branches were removed and replaced by an 8" cast iron main with cast iron branches.

Repairs were made to bells and speaking tubes, hose, plumbing, gas, water and steam pipes. The Chief Inspector's office was furnished with chairs, linoleum and mats.

Works carried out under the supervision of Mr. W. J. McCordock, C.E.

#### SAVINGS BANK.

The outside brick and stonework was pointed. New iron tops were fitted on chimney and painted. The wood strips were removed from outside of sashes and the glass secured with points and putty. The division wall between club and bank pro-

perty and the wall on Canterbury street were repaired and pointed. All sashes and frames, as well as the flagstaff, were painted. The inside woodwork was set up, the plastering repaired, the ceilings cleaned, and in the two upper flats the walls and woodwork were cleaned, painted, grained and varnished.

Repairs were made to gas and water pipes, and new blocks and halyards furnished flagstaff.

Works carried out under the supervision of Mr. W. J. McCordock, C.E.

## PROVINCE OF PRINCE EDWARD ISLAND.

### CHARLOTTETOWN.

#### DOMINION BUILDING.

An iron enclosure fence was put up around the grounds. The furnace, drain and tank were repaired and the woodwork painted.

Supervising architect, Mr. W. E. Harris.

## PROVINCE OF QUEBEC.

### AYLMER.

#### POST OFFICE.

A tower clock was placed in the attic, having one skeleton dial on the front gable; the facing brick having in some cases disintegrated, were taken out and replaced by new; a fireproof safe was supplied for the postmaster's use, and the pump repaired.

Plans, &c., prepared, and work carried out under the supervision of this Department.

Contractor for clock, Mr. E. Chanteloup, Montreal.

### CHICOUTIMI.

#### MARINE HOSPITAL.

The drain referred to in last year's report was continued into the river and a cribwork built for its protection, the ground and first floors of the covered way were painted; a new stairway of 84 steps was built and a new water tank provided.

Work done under the supervision of this Department.

### COATICOOK.

#### PUBLIC BUILDING.

Storm sashes were supplied for all windows, and minor repairs executed.

### FRASERVILLE (RIVIÈRE DU LOUP).

#### POST OFFICE, &c., BUILDING.

This building which was described in my report of last year has been in progress since then and it is expected will be roofed in by the coming autumn.

Plans, &c., prepared and work superintended by this Department.

Clerk of works, Mr. Elzéar Marquis, Fraserville.

Contractor, Mr. Alfred Lortie, Quebec.

### GROSSE ISLE.

#### QUARANTINE STATION.

*Western Division.*—Three compartments of the washhouse building each 24 feet by 24 feet were fitted up as lavatories and one compartment 18 feet by 24 feet

as a laboratory. Each lavatory compartment contains 6 bath rooms and 8 water closets, having galvanized iron floor, partitions and doors and galvanized wire mesh ceiling. The baths are connected with a hot water tank, supplied by a hot water heater, and the baths and closets with cold water from a tank supplied by a hand pump. The laboratory is fitted up with sinks, tables, shelving, &c. A fence 81 feet long was constructed to render the entrance to the women's compartment private.

Two semi-detached kitchens 30 feet by 10 feet were built in the rear of the police sergeant's clock, and doors of communication made thereto from the buildings. The Protestant parsonage and outbuildings were repainted outside.

*Middle Division.*—The stairway halls of the superintendent's residence were painted and a new wardrobe constructed in one of the bedrooms.

The well house was renewed.

An addition was made to the kitchen of one of the boatmen.

*Eastern Division.*—In the 5 tenements occupied by the hospital corps the plaster was repaired, the walls coloured and the ceilings whitewashed and the inside wood-work painted two coats.

A wood shed 24 feet by 16 was built at the east end of the steward's quarters, and in the rear two sheds 18 feet by 12 feet and 16 feet by 12 feet respectively.

About 380 feet of enclosure fencing, including two small gates, were constructed around the bleach ground, and a new winter sash and frame was provided for the disinfecting house.

Plans, &c., prepared and work carried on under the supervision of this Department.

Contractors for plumbing, Mr. Geo. T. Philips and Mr. James Maguire.

Contractor for the remaining works, Mr. Ferdinand Poitras, Quebec.

## HULL.

### POST OFFICE.

The internal walls were tinted and the ceilings whitened: a hot water system for bath and sinks was put in, and plumbing repaired.

## LACHINE.

### POST OFFICE, &C., BUILDING.

This building, which was described in my report for last year, is nearly completed and tenders are about to be called for the Post Office fittings.

Plans, &c., prepared and work supervised by this Department.

Clerk of works, Mr. Jos. Mettayer, Lachine.

Contractor, Mr. Jos. Fitzpatrick, Joliette.

## MONTREAL.

### CUSTOM HOUSE.

The old wooden skylight over central hall having become leaky and dangerous was replaced by one of iron. Four pan closets and two wash-out urinals were taken out and replaced by closets and urinals of more approved pattern, having tiled floors and marble divisions between urinals; and the lead w. c. pipe was taken out and replaced by heavy cast iron pipe. Owing to the new shed darkening the rotunda of the Custom house and the engineer's kitchen, further gas fittings had to be supplied. A new speaking tube was put in to communicate between collector's office and surveyor's office. Minor repairs were made to hardware, plumbing, &c.

Superintending architect, Mr. James Nelson, Montreal.

### EXAMINING WAREHOUSE.

The McGill and Common streets sidewalks were renewed. New wire ropes were put in store hoist and grocery hoist; hatches and cage were repaired, and new oak

floors put in drug hoist and dry goods hoist; the fancy goods hoist was provided with a new steel drum and repaired, and a new steel shaft with extra hanger was provided for the express hoist. The elevator gangways were repaired and furnished with new angle irons. A new ash waggon and shoot therefor was furnished and the track altered and stayed with rods. The galvanized iron gutter in the middle of roof was renewed. The iron drain pipe of the hardware department was renewed, a new heating coil was put in for the assistant appraiser of drugs and chemicals, a new galvanized iron tank put in, and minor repairs done to boiler fittings, plumbing, &c.

Superintending architect, Mr. James Nelson, Montreal.

#### INLAND REVENUE OFFICES.

Six water closets of obsolete pattern were taken out and replaced by others of approved pattern with ventilator pipes, &c., complete.

To prevent dampness and entrance of water, the flooring of the basement was taken up, and a bed of concrete made and double wood floor laid, involving the taking up and replacing plumbing, base, &c., re-hanging doors, repairing plastering, cleaning, tinting, painting, &c.

Works carried out under the supervision of Mr. A. Raza, architect, Montreal.

#### POST OFFICE.

In accordance with a request from the Post Office Department a cast iron stairway, giving a more direct communication between basement and ground floor, was constructed, and the unfinished basement was altered, fitted up and furnished for a distribution office.

The large elevator was supplied with a new gangway, new valves in pump chambers, new spindles, new Pect valve and new wire ropes; the valve chest was repaired and marline put on stopper rope. The letter elevator had a new belt and marline on stopper rope. In inspector's suite a new urinal was put in, the w. c. cleaned and plumbing repaired.

Sundry repairs were made to drain pipes, gas pipes, water pipes and plumbing. Superintending architect, Mr. James Nelson, Montreal.

#### QUEBEC.

##### CULLERS' OFFICE.

Additions were made to the heating and plumbing.

##### CITADEL—HIS EXCELLENCY'S QUARTERS.

A new summer house was erected on the terrace; the floors of the upper room and tennis court relaid; the inside woodwork cleaned, repainted and repaired; the walls repaired and papered; new carpets were supplied for drawing-room and passage; a movable porch was built at entrance; electric bell service was extended; the band-room was enlarged; repairs were made to plumbing and stoves; and the basement and coachman's quarters were distempered.

A tent was fitted up in summer house on terrace; the ball-room was decorated, and repairs made to range, furniture, &c.

Work done under the supervision of this Department.

##### EXAMINING WAREHOUSE.

Masonry around windows and doors and the setting of frames were pointed in cement; a flagstaff, with hatch and railing, were constructed on roof, a small skylight put in, the plumbing put in good repair, and some minor work done to boiler, &c.

#### POST OFFICE.

Two galvanized iron chimney tops to furnace flues provided; repairs were made to the money order and stamps safe door, plumbing work, ceiling of care-

taker's rooms, gas fixtures and inspector's office fittings. A letter and newspaper shoot was put in.

## RICHMOND.

### PUBLIC BUILDING.

Negotiations for the purchase of a site are in progress.

## ST. HENRI.

### POST OFFICE.

A contract for the erection of this building on part of lot 1925, Notre Dame street, was entered into on 13th October, 1890. It is to have a frontage of 43 feet 6 inches, by a depth of 33 feet 6 inches, and have two stories, basement and cock loft. The front and flank walls are to be stone and the rear wall brick; the partitions, floors and roof to be of wood. The ground floor is to be occupied as a Post Office, and the first floor as caretaker's apartments, excepting a room for the Inland Revenue and w. c.

Plans, &c., prepared by this Department.

Local architect, Mr. Alph. Raza, Montreal.

Contractors, Messrs. Frigon & Peltier.

## ST. HYACINTHE.

### POST OFFICE, &c., BUILDING.

On 19th May, 1889, a site was purchased having a frontage of 81 feet 6 inches and 133 feet 3 inches on Girouard and St. Joseph streets, respectively, and on 19th July, 1890, a contract for the erection of the building was entered into. The building is to be 56 feet by 48 feet, and have a sub-basement and basement of stone, surmounted by two stories faced with stone and a mansard attic, the floors, partitions and roof being of wood. On the street corner is to be a square tower, 16 by 16, 4 stories above ground. The sub-basement is for the furnace and fuel; the upper basement for examining warehouse, gas inspection and weights and measures; the ground floor for the post office; the first floor for the Customs and Inland Revenue offices; and the attic for caretaker's apartments.

Plans, &c., prepared by this Department.

Clerk of works, Mr. Jos. Chenette.

Contractors, Messrs. Lortie & Naud.

## ST. VINCENT DE PAUL.

### PENITENTIARY.

The following works were carried out by convict labour under the supervision of this Department.

*West Dormitory Wing.*—This building has been supplied with steam heating coils connected with the heating boilers. The number of coils appears to be 132 not 120 as stated in my report of last year.

*Boundary Wall.*—550 ft. lin. of this wall which was described in my report of last year, are built together with the wall of the circular angle tower, 16 feet diameter, to contain the stairs by which the guards are to scale the wall. The stone was brought from the quarries 2 miles distant, for its speedy delivery 4 large derricks and 5 additional tramway trucks were made and used.

*North Lodge and Gatehouse.*—This building through which are to pass all supplies and all building material required inside the gates, which is to contain dwellings for two gatekeepers, has been commenced and is now in progress.

*Chaplain and Chief Keeper's Outbuilding.*—A stable and a wood shed each 18 ft. by 20 ft. of wood have been built.

*Fencing.*—An open paling fence 250 ft. in length and 6 ft. in height enclosing the grounds at the engineer's quarters being beyond repair was replaced by a new one of the same style, and a fence of similar height about the back grounds and garden of warden's residence 120 feet in length of which was built during this fiscal year and 150 ft. in the previous one.

*Water Supply.*—To supply water for the building operations and for better heating the workshops, an additional 30 H. P. boiler was supplied.

*Hospital.*—A sulphur bath and w. c. were put in.

*Repairs.*—The original prison buildings and old outbuildings were extensively repaired, the tin roof covering of the original prison building and that of the smith's shop were removed and replaced by galvanized iron and the outside stone walls pointed in cement.

*Painting.*—The window and door frames, sashes, door and all exposed woodwork of the prison buildings and the exterior woodwork of eight dwellings, known as guards' cottages, have all been painted, and the exposed ironwork, such as window barriers, cell doors, steam-piping, &c., were japanned.

The eight guards' cottages, owing to their exposed position facing the north, were each supplied with an entrance porch.

Plans, &c., prepared and work supervised by Mr. Jno. Bowes, superintending architect.

### ST. JEROME.

#### PUBLIC BUILDING.

The Customs offices were fitted up and furnished, and sundry repairs done to plastering.

### THREE RIVERS, PLATON.

The retaining wall was repaired and pointed.

Superintending architect, Mr. J. A. Pothier, Three Rivers.

### THREE RIVERS.

#### CUSTOM HOUSE.

The shingled roof was repaired.

Superintending architect, Mr. J. A. Pothier, Three Rivers.

### JOLIETTE.

#### POST OFFICE, &c.

The Customs offices were supplied with furniture; a portion of the yard was fenced off, and some usual and ordinary repairs executed.

### VALLEYFIELD.

#### POST OFFICE.

A building was leased by the Department and altered to suit the requirements of the Post Office Department, under the supervision of this Department.

Contractors, Messrs. Bélanger & Préfontaine, Valleyfield.

## PROVINCE OF ONTARIO.

### ALMONTE.

#### POST OFFICE, &c., BUILDING.

This building which was described in a previous report has been fitted up, furnished, supplied with a heating apparatus and occupied.

Plans, &c., prepared and work supervised by this Department.

Clerk of works, Mr. Andrew Bell, Almonte.

Contractor for the construction of the building and fittings, Mr. Robert Cameron, Almonte.

Contractors for heating apparatus, Messrs. Dunlop & Chapman, Pembroke, Ontario.

### BRAMPTON.

#### POST OFFICE, &C., BUILDING.

The Customs offices were fitted up and furnished; gas fittings were supplied and a granolithic sidewalk laid on the street front under the supervision of this Department.

### BROCKVILLE.

#### PUBLIC BUILDING.

In accordance with the regulations of the Board of Service Commissioners the w. c., urinals, wash-basins, sinks, &c., were separately trapped and ventilated, and various incidental alterations and improvements made in the plumbing of the building.

### CARLETON PLACE.

#### POST OFFICE, CUSTOM HOUSE AND INLAND REVENUE OFFICES.

On 9th December, 1890, a contract was entered into for the construction of this building on part of lot 8, section D, having a frontage of 60' by a depth of 104' 6". The building is to be of stone, two stories, basement and attics, 45' by 48', with a one-story brick annex 31' by 21' in rear, and having the floors, partitions and roofs of wood. The basement is for furnace and fuel rooms, the ground floor of main building for Post Office purposes and the annex for an examining warehouse.

Plans, &c., prepared by this Department.

Clerk of works, Mr. Andrew Bell, Almonte, Ont.

Contractor, Mr. R. Cameron, Almonte, Ont.

### COBOURG.

#### POST OFFICE, CUSTOM HOUSE, &C.

Further works of plumbing were effected; hose was supplied, and arrangements for the fitting up and furnishing of the Customs offices are being made.

### GANANOQUE.

#### CUSTOM HOUSE.

Owing to the offices being damaged by fire, repairs and new furniture were required and supplied.

### GODERICH.

#### POST OFFICE, &C., BUILDING.

Building completed and occupied.

Plans, &c., prepared and work supervised by this Department.

Supervising architect (since decease of Mr. G. F. Durand) Mr. Joseph Henry, London.

Clerk of works, Mr. Edward Sharman, Goderich.

Contractors for building, Messrs. Tambling & Jones, London.

Contractors for heating apparatus, Messrs. Garth & Co., Montreal.

### GUELPH.

#### POST OFFICE.

The basement walls were kalsomined, and ordinary and usual repairs effected.

## HAMILTON.

### POST OFFICE, &C., BUILDING.

Minor repairs were made to examining warehouse and main building roof ; a new cable was put in elevator machinery ; a pigeon-hole case was supplied examining warehouse ; some locks, hinges, glass, door-springs, window-shades, linoleum, &c., were supplied.

## OTTAWA.

### CENTRAL EXPERIMENTAL FARM.

During the fiscal year the following buildings were constructed :

A one-story wooden dairy, comprising a working room 30 ft. by 18 ft., a cheese room 20 ft., an engine room 9 ft. by 10 ft., an ice-house 24 ft. by 18 ft., and two refrigerators 9 ft. by 11 ft.

An engine house of wood, 35 ft. by 15 ft.

A one-story wooden piggery 81 ft. by 24 ft., containing a feed room 24 ft. by 20 ft., and two rows of seven styes each, divided by a passage.

The fence on the line of the railway passing through the farm was taken down and replaced by one similar to that enclosing the farm.

General repairs were made to buildings and fence.

Work done under the supervision of this Department.

Clerk of works, Mr. Wm. Davidson.

### EASTERN BLOCK, DEPARTMENTAL BUILDING.

The corridors of basement and first floors were cleaned, tinted and painted, and the covering of the boiler-house was renewed.

Works carried on under the supervision of this Department.

### GEOLOGICAL MUSEUM.

The roofs of caretaker's house, store room and woodshed were renewed and the walls painted.

### GOVERNMENT HOUSE.

The walls of the conservatory being out of plumb and dangerous and the plates decayed new ones were placed outside of them and connected by iron rods, by which means the walls were made upright and the building secure from spreading, and posts put in to support the ridge ventilator ; 150 feet of plant tables which had become decayed were replaced. (Note—The word "conservatory" in report of last year should have been "grapery.")

625 lineal feet of 7 feet fence on McKay street and Bay road were rebuilt.

A tile drain 85 feet in length was laid from the rear of the Gate Lodge across the roadway to edge of cliff to carry off surface water.

The gravel roof of the studio was renewed, the bathroom No. 10, first floor, was divided from w. c.'s by a wood partition ; the plastered ceiling of the tennis court sheathed with narrow V-jointed pine, painted white.

Fallen portions of the plastered ceilings and cornices were made good, and the brickwork of furnaces and outside brick walls repaired.

At the curling rink a new stair was built from ground floor to refreshment room, and the waiting room ceiling sheathed with V-jointed stuff, stained and varnished.

The front wall of the guard room being decayed was taken down and rebuilt.

A new sanitary closet was fitted up in the basement of the cottage.

At the stables the messroom was enlarged to double its former size, and a shed for firewood constructed.

Partial renewals of timber of Bay road bridge and sidewalks of ground were made.

All broken glass was renewed in conservatories, vinery, and buildings generally, as well as in double windows.

Repairs were made to the box drain of stable, the toboggan slide, house furniture, blinds, curtains, &c., &c.

1,850 sup. yards of distempering, 1,750 sup. yards of painting, and 1,150 sup. yards of papering were done throughout the house, cottage and stables; 665 yards of new carpet were supplied and laid in ground and first floor corridors of the house and in oval room No. 1, the old carpets taken up being used elsewhere; 34 yards of cocoa matting were laid in passages, and 24 rugs and mats supplied. All the carpets and matting throughout were taken up, cleaned, repaired and relaid.

A large quantity of china and glassware was provided to bring the stock up to the standard, and the remainder of the dinner china formerly used sent to Quebec for use at His Excellency's quarters there.

The worn-out articles of linen were replaced by others; the kitchen coppers were retinned, the flags were renewed and repaired from time to time; loose covers in cretonne were provided for drawing-room chairs, and some lounges and chairs recovered.

The lawns, conservatories, gardens and grounds have been efficiently kept.

Work carried out under the supervision of this Department.

Clerk of works, Mr. Wm. Hutchinson.

Contractors for maintenance of grounds, &c., Messrs. Sorley & Sims.

#### MAJOR'S HILL PARK.

The contractor having maintained the grounds to the satisfaction of this Department a further contract for a period of three years was entered into.

Contractor, Mr. L. Garelo.

#### PARLIAMENT BUILDING.

The walls of the Library were pointed. The skylights over House of Commons and Senate Chambers were repaired; the roofs of the boiler-house were recovered and the w.c.'s, &c., repaired, under the supervision of this Department.

#### NEW DEPARTMENTAL BUILDINGS, WELLINGTON STREET.

Rooms for the occupation of the Census branch of the Department of Agriculture were fitted up and furnished, and furniture supplied to the Post Office Department, the Department of Indian Affairs and the Department of Agriculture, under the supervision of this Department.

#### PARLIAMENT GROUNDS.

The grounds having been maintained efficiently and to the satisfaction of this Department, a further contract for a period of three years was entered into.

Contractor, Mr. N. Robertson, Ottawa.

#### PRINTING BUREAU.

The Parliamentary distribution was fitted up and a complete electric light plant with 500 lights installed.

Plans, &c., prepared and work supervised by this Department.

Superintending architect, Mr. J. P. M. Lecourt.

Clerk of works, Mr. H. L. Pinard.

Contractor for building and fittings, Mr. Jno. E. Askwith, Ottawa.

Contractor for electric lighting, Messrs. Ahearn & Soper, Ottawa.

#### PUBLIC BUILDINGS, REPAIRING STREETS, &c.

Scraping, cleaning and repairs were done the roadways of East and West Canal streets, Nepean Point roadway, Wellington, Bank, Metcalfe, Elgin and St. Patrick streets, Major's Hill roadway, Little Sussex street, also the yards of the Printing Bureau, Museums, Post Office and old Pump House. The sidewalks and crossings of Wellington street, Cartier Square, St. Patrick street and at the Museums were repaired; the grass at Geological Museum and Cartier Square was kept clipped;

and the ashes were removed from the Langevin Block, Museums and Printing Bureau.

The various roadways, sidewalks, footpaths, roofs and yards were kept clear of snow during the winter.

#### SUPREME COURT ADDITIONS.

A contract was entered into on 28th October, 1890, for an extension of the aforesaid building northerly 71 feet in length by 47 feet in breadth, the extension to be two stories, basement and attic and corresponding finish and detail with the present building. There are to be on the first floor, six rooms for judges, a messenger's room and w.c.'s; and on the ground floor a waiting room, a spare room and a room each for registrar, messengers, reporters, Bar and Attorney General.

Plans, &c., prepared by this Department.

Contractor, Mr. Wm. Stuart, Ottawa.

Clerk of works, Mr. J. L. Pinard.

#### WESTERN BLOCK, DEPARTMENTAL BUILDING.

That portion of the attics extending northward from the eastern entrance stairway was partitioned off, forming a double row of offices separated by a corridor, required by the Mounted Police Department, were finished and furnished. The corridors of the western extension were cleaned, tinted and painted, and the cement floors throughout the building repaired. The roof covering of boiler-house was recovered.

Works carried out under the supervision of this Department.

#### VICTORIA HALL.

The skylights were renewed and painted, under the supervision of this Department.

#### ORILLIA.

##### PUBLIC BUILDING.

Plans are about to be prepared by this Department for this building, which is to be situated on the northerly 75 feet of lot No. 6 survey, measuring 75 feet on Peter street by 105 feet: a site presented to the Government by the Corporation of Orillia.

#### PETERBOROUGH.

##### CUSTOM HOUSE.

A site was obtained consisting of lot No. 1 south of Charlotte street and east of George street measuring 80 feet by 114 feet; and on 26th August, 1890, a contract was entered into for the construction of a Custom house building thereon. The building is to have brick walls with stone dressings and foundations, and consist of main building 34 feet by 50 feet having two stories, basement and attic, with a one-story annex, 31 feet by 17 in rear. The basement is to be for furnace and fuel rooms, the ground floor for Inland Revenue Offices, examining warehouse and water closet, the first floor for the Customs Offices and the attic for the caretaker's apartments.

Plans, &c., prepared by this Department.

Architect, Mr. Jno. E. Belcher.

Contractor, Mr. Jno. E. Askwith.

#### PETROLEA.

##### POST OFFICE, &C., BUILDING.

A site has been purchased on the corner of Petrolea and Wingfield streets with frontage of 60 feet and 150 feet respectively.

## PORT ARTHUR.

## POST OFFICE.

Negotiations with a view to obtain a site are now in progress.

Plans for this building are in course of preparation, and it is expected that tenders will be called for at an early date.

## PRESCOTT.

## POST OFFICE, CUSTOM HOUSE AND INLAND REVENUE OFFICES.

Buildings completed and occupied.

Plans, &c., prepared and work superintended by this Department.

Clerk of works, Mr. David Barr, Prescott.

Contractors for the building and fittings, Messrs. Cairns, Ward & Steele, Prescott.

Contractor for heating apparatus, Mr. Ellsworth Smart, Brockville.

## SMITH'S FALLS.

## PUBLIC BUILDING.

Negotiations for the purchase of a site are in progress.

## STRATFORD.

## PUBLIC BUILDING.

Repairs to the roof, carpenter work, painting and masonry were made.

## ST THOMAS.

## POST OFFICE, &amp;c., BUILDING.

Repairs to plumbing and roof were effected.

Supervising architect, Mr. W. Whaley.

## TORONTO.

## CUSTOM HOUSE.

The plumbing throughout was completed, sundry works in connection therewith and minor alterations and repairs were done to building and heating apparatus. Superintending architect, Mr. D. B. Dick.

## OBILL HALL.

Plans, &c., for this building are in progress.

## EXAMINING WAREHOUSE.

Exhaust pipe was extended over roof of building, block pavement was repaired, heating coils in apparatuses were altered and sundry general repairs were effected under the supervision of Mr. D. B. Dick, architect.

## INLAND REVENUE OFFICES.

Repairs were made to heating apparatus, to sections of hot water boiler, &c., under the supervision of this Department.

## POST OFFICE.

The heating apparatus, pipes in basement were taken down and rearranged, the building was visited by the architect, the interior of the building was repainted and cleaned and some minor alterations to the roof was made, and sundry alterations and repairs effected.

Supervising architect, Mr. D. B. Dick.

## PROVINCE OF MANITOBA.

### BRANDON.

#### EXPERIMENTAL FARM BUILDING.

The works referred to in my report of last year are completed and the buildings occupied.

#### POST OFFICE.

This building is nearly completed, and is furnished with a hot water heating apparatus, but is not yet fitted up or furnished for occupation.

Plans and specifications prepared by this Department.

Superintending architect, Mr. W. R. Marshall, Brandon.

Clerk of works, Mr. F. J. Chubb.

Contractor, Mr. James Hanbury, Brandon.

### WINNIPEG.

#### IMMIGRATION BUILDING.

On 3rd September, 1890, a contract was entered into for its construction.

The building is 30' x 126' 8", of wood, two stories and attics, with a kitchen in rear, and having a stone basement under all. The basement is to contain a wash room, a fuel room, bath rooms, water closets and store rooms, the ground floor men and women's wards, kitchen, intelligence office, agents and assistants offices, &c., the first floor men and women's wards, dressing rooms, store rooms and baggage rooms.

Plans, &c., prepared by this Department.

Resident clerk of works, Mr. D. Smith.

Contractors, Messrs. Parker & Charlesworth.

#### POST OFFICE.

Additional lock boxes were supplied; the steam boiler in basement was bricked in; repairs were made to plaster, painting, &c., and a large number of minor works of alteration and repairs effected under the supervision of this Department.

Clerk of works, Mr. D. Smith, Winnipeg.

### ST. PAUL'S.

#### INDUSTRIAL SCHOOL.

A fire protection apparatus, as well as hose, hose-reels, &c., were provided.

## NORTH-WEST TERRITORIES.

### CALGARY.

#### BARRACKS.

A wash room was formed in basement and a drain taken therefrom to river.

Clerk of works, Mr. H. D. Johnson, Calgary.

#### COURT HOUSE.

The heating apparatus referred to in my report of last year was completed; the floor of the boiler room was lowered, a cesspit and drain put in; the Court room, Sheriff's office, Clerk's office, &c., fitted up, and the entire building furnished.

Plans, &c., prepared and work supervised by this Department.

Clerk of works, Mr. H. D. Johnson, Calgary.

Contractor for heating apparatus, Mr. W. D. McDonald, Winnipeg, Man.

## INDIAN HEAD.

### EXPERIMENTAL FARM BUILDINGS.

Three outside latrines were built: a windmill and pump was supplied, also materials for a granary and a stable.

## LETHBRIDGE.

### BARRACKS.

The hospital kitchen referred to in my report of last year was completed; a tank over bath room with hot and cold water service was put in, and sergeants' mess room and sergeant-major and quartermaster-sergeant's rooms were lined and ceiled with building paper, and 1 in. dressed lumber, oiled and varnished.

Plans, &c., prepared and work carried out under the supervision of this Department.

Clerk of works, Mr. H. J. Peters, Regina.

## MACLEOD.

### BARRACKS.

A new bake-oven and a blacksmith shop were built, also a house in corral west of barracks. The south end of quartermaster's store was fitted up as a canteen; "H" stable walls have been gutted, new floors, divisions and doors put in and a saddle room wing built, and "D" and "H" Divisions' barracks were re-sided. All the works were done by police labour, under the supervision of this Department.

### OUTPOSTS.

A one and one-half story stand-off detachment house, 24 feet by 30 feet, with kitchen lean-to, 14 feet by 14 feet; also, saddle and oats room, 14 feet by 16 feet; stable, 24 feet by 72 feet; latrine and hay corral were built by police labour, under the supervision of this Department.

Clerk of works, Mr. H. J. Peters, Regina.

## MAPLE CREEK.

### MOUNTED POLICE BARRACKS.

The wing of a proposed new hospital, consisting of one ward 16 ft. by 30 ft. of wood on a stone foundation, to be used as a surgery and bath room with cellar and tank, a kitchen lean-to 12 ft. by 18 ft. and a sick stable 22 ft. by 32 ft., were erected under the supervision of this Department.

Clerk of works, Mr. H. J. Peters, Regina.

## MOOSOMIN.

### COURT HOUSE.

Building completed and occupied.

Plans prepared and work carried out under the supervision of this Department.

Clerk of works, Mr. Chas. Taylor, Moosomin.

Contractors, Messrs. Williams & Willoughby, Regina.

## POLICE BARRACKS GENERALLY.

Various and numerous repairs and renewals, not elsewhere enumerated in this report, were carried out by police labour at the Police posts at Prince Albert, Battleford, Fort Saskatchewan, St. Albert, Calgary, Fort Macleod, Lethbridge, Maple Creek and Regina, also at the Wascana dam, under the supervision of this Department.

## QU'APPELLE.

## IMMIGRANT BUILDING.

The court room and offices referred to in my report of last year are being fitted up in this building and supplied with furniture, stoves, stovepipes, flagpole and flag. Clerk of works, Mr. H. J. Peters, Regina.

## REGINA.

## BARRACKS.

An elevated tank to hold 50,000 imperial gallons for fire protection has been completed ready to receive water. The cellars of the two main barrack buildings were refloored with 2 in. plank and gravel, all the coal shoots enlarged and truss rods of girders tightened.

Plans, &c., prepared and work carried out under the supervision of this Department.

Clerk of works, Mr. H. J. Peters, Regina.

## COUNCIL CHAMBER—NEW OFFICES.

On 17th June, 1890, a contract was entered into for this building, which is now nearly completed. It is situated on the Government reserve, consists of a brick building on a stone foundation 86 feet by 24 feet, having basement, one story and mansard, to contain in the basement a boiler room, a fuel room, a vault, w. c.'s, and store rooms; on the ground floor the offices of the Lieutenant Governor, Finance Department, Mr. Gordon, Mr. Bourget, clerks, &c., and two vaults; and on the first floor two offices for Board of Education, two for Public Works, one for Records and one spare office. Drains and cesspit have been provided, and plans for a heating apparatus prepared.

Plans, &c., prepared by this Department.

Resident clerk of works, Mr. H. J. Peters, Regina.

Contractors, Messrs. J. R. Reilly & Co.

## COURT HOUSE.

The arrangement of divisions on west side of ground floor were altered by taking down partitions, moving back vestibule door to entrance lobby and making new entrance to the offices occupied by the Dominion Lands officials since December, 1890. These offices have been provided with fittings, carpets and heating apparatus.

The old stable in rear of the building has been fitted up as a caretaker's dwelling.

Works carried out under the supervision of this Department.

Clerk of works, Mr. H. J. Peters, Regina.

## GAOL AND LUNATIC ASYLUM.

The soft water system, the boiler-house and the two pairs of cottages mentioned in my report of last year were completed, the cottages being occupied.

A boiler plate flooring has been laid on top of ceiling joists of prison to prevent escape through ceiling.

Works carried out under the supervision of this Department.

Clerks of works, Mr. H. J. Peters, Regina.

## IMMIGRANT BUILDING.

Latrines and a fence 6 feet in height with necessary gates to enclose property, were erected under the supervision of this Department.

Clerk of works, Mr. H. J. Peters, Regina.

## INDUSTRIAL SCHOOL.

A system of water supply for fire protection consisting of 3 tanks of 7,000 gallons capacity each were constructed in roof, supplied by a force pump in basement. Lava-

tories and bath rooms for boys and girls were fitted up; and drains and cesspit, as well as a large stone pit for ashes, &c., built.

Plans, &c., prepared and work carried out under the supervision of this Department.

Clerk of works, Mr. H. J. Peters, Regina.

#### NEW RESIDENCE FOR THE LIEUTENANT GOVERNOR.

The heating apparatus was put in and the building is being furnished ready for occupation.

The Government reserve consisting of the N.-W. quarter of section 23, township 17, range 20, west of 2nd meridian, was enclosed with a woven wire fence having cedar posts.

Plans prepared and work carried out under the supervision of this Department.

Clerk of works, Mr. H. J. Peters, Regina.

Contractor, Mr. Wm. Henderson, Regina.

#### WHITEWOOD.

##### IMMIGRANT BUILDING.

This building has been fitted up with benches, tables, cots, stoves, stovepipes, lamps, &c., &c.

### PROVINCE OF BRITISH COLUMBIA.

#### AGASSIZ.

##### EXPERIMENTAL FARM.

On 28th February last a contract was entered into for the erection of a Superintendent's residence, which is now completed and occupied. It is a wooden building consisting of two stories, basement and attics, having on the ground floor a staircase hall, a sitting room, a dining room, an office, a kitchen and a shed, on the first floor 4 bedrooms and in the attic 3 bedrooms.

Plans, &c., prepared by this Department, work supervised by Mr. F. C. Gamble, C. E.

Clerk of works, Mr. Joseph Brown.

#### ALBERT HEAD.

##### QUARANTINE STATION.

A desk was supplied to the quarantine officer.

#### KAMLOOPS.

##### INDIAN INDUSTRIAL SCHOOL.

The interior has been wainscotted and minor repairs executed, under the supervision of Mr. F. C. Gamble, C. E.

#### NANAIMO.

##### POST OFFICE, &c.

Furniture was supplied to the Customs Offices, and trifling repairs to locks, &c., effected under the supervision of Mr. F. C. Gamble, C. E.

#### NEW WESTMINSTER.

##### PUBLIC BUILDING.

Preparations for the enlargement of the Post Office room were made, but owing to unforeseen circumstances the works have not been carried out. A stove was supplied to the Fisheries Office, and some broken glass, &c., replaced.

Works carried out under the supervision of Mr. F. C. Gamble, C. E.

## VANCOUVER.

### IMMIGRATION BUILDING.

Beds, stretchers, tables, chairs, stove, &c., have been furnished.

### POST OFFICE, &c., BUILDING.

On 27th October, 1888, a site was purchased on the corner of Pender and Gravelle streets, having frontages of 130 feet and 75 feet respectively, and on 2nd August, 1890, a contract was entered into for the construction of the building. There is to be a 3-story and basement stone main building, L shaped in plan, 81 feet by 64 feet, and a one-story and basement annex in rear, 35 feet by 55 feet. The basement under main portion is to be divided by brick partitions and be used for furnace room, fuel room and Post Office storage; the basement under the annex for bonded goods. The ground floor of the main building is to be the Post Office, and that of the annex the examining warehouse; the first floor is to contain the offices of the Customs, Inland Revenue and Post Office Inspector, and the second floor offices not yet distributed. There are to be brick vaults, one on the ground floor for the Post Office, and two on the first for the Inland Revenue and Custom House.

Plan prepared by this Department.

Resident architect, Mr. C. Osborn Wickenden, Vancouver.

Contractor, Mr. A. E. Carter, Vancouver.

## VICTORIA.

### "O" BATTERY BARRACKS.

A contract was entered into on 31st December, 1890, for the erection and completion of guard house, entrance gate, cook house, married men's quarters and canteen, all of which were completed.

Officers' quarters had water laid on and taken into kitchens, a urinal fitted up and electric bells put in; lumber was supplied for sidewalk, and metal and gravel for road;  $3\frac{1}{4}$  acres of barrack property was cleared, grubbed and ploughed; the property was fenced, and cupboard, ranges, iron shelving, hose and hose reels were supplied.

Plans, &c., prepared, and work supervised by this Department.

Supervisor, Mr. F. C. Gamble, C.E., Victoria.

Contractor, Mr. Geo. Macfarland.

## GENERALLY.

Usual and ordinary repairs and minor alterations were executed; sundry articles of furniture and fittings were provided, cleaning, colouring, painting and other improvements effected to a large number of buildings not herein referred to.

## ENGINEERS, ENGINEMEN, FIREMEN, &c., PUBLIC BUILDINGS.

The various engineers, enginemen, firemen and caretakers, and the heating apparatus of Dominion Public Buildings, with the exception of those at the various penitentiaries and the military buildings, are under the control of this branch of the Department, and number 120 in addition to the Staff of Ottawa buildings.

## HEATING DOMINION BUILDINGS (FUEL).

Tenders were invited by public advertisement for the supply of coal at 115 of the public buildings, and coal and wood supplied to over 115 buildings in all.

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### WATER FOR DOMINION BUILDINGS.

The water supply for the various public buildings, excepting at Ottawa, and the penitentiaries and military buildings, is controlled by this branch of this Department; 61 buildings at 40 localities have water services connected with the water supply of the local water works companies, the remainder being in general supplied with wells, pumps and tanks.

### LIGHTING DOMINION BUILDINGS.

The lighting of the various Dominion buildings, excepting at Ottawa, and the penitentiaries and military buildings, is under the control of this branch of the Department. Of these buildings 63 were lighted by gas, 19 by incandescent electric light, 2 by gasoline, 1 by natural gas, and the remainder by coal oil, while at several of the last mentioned the entrance is illuminated by an arc light outside.

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APPENDIX No. 3.

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REPORT

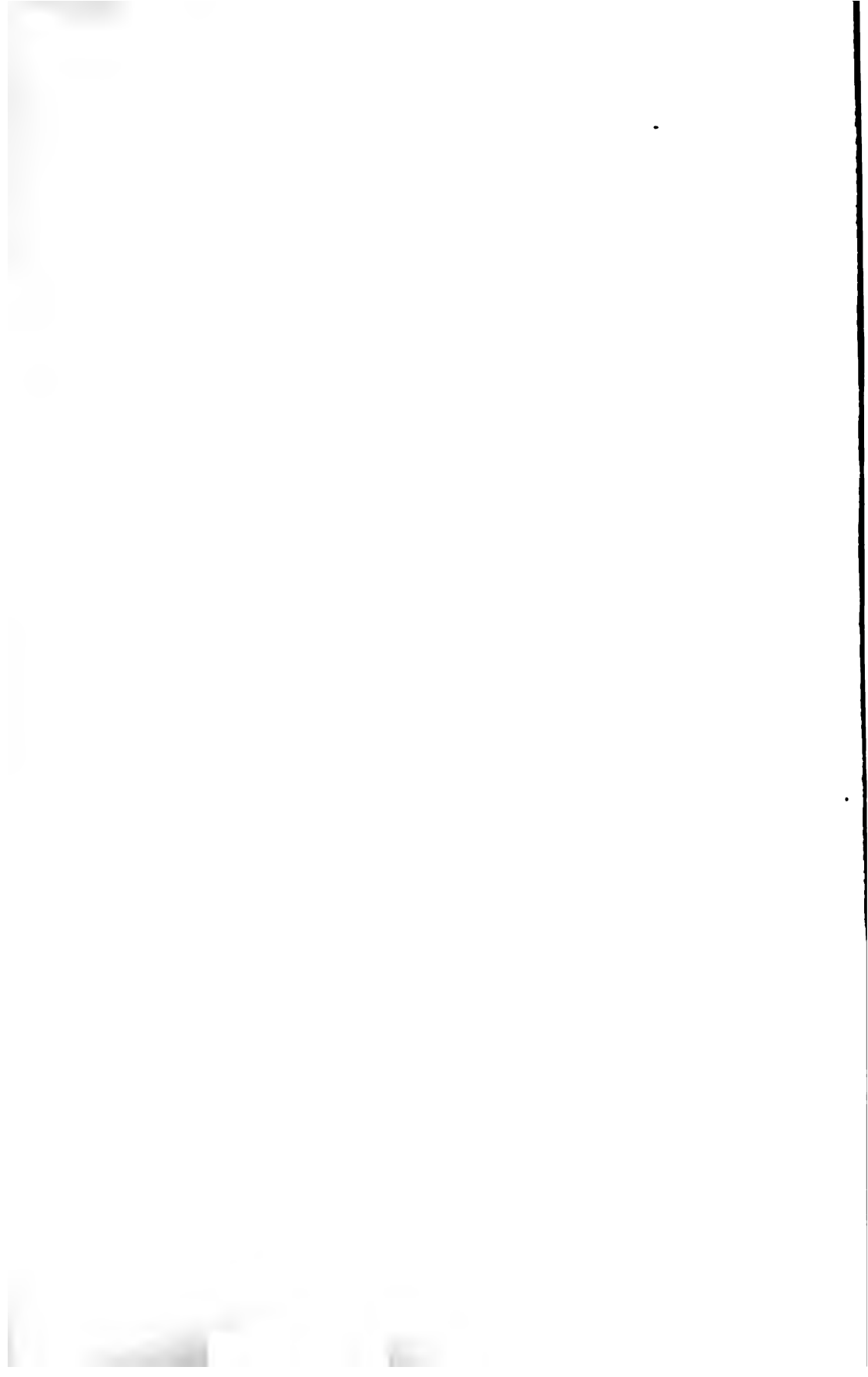
ON

HARBOURS AND RIVERS, DREDGES, DREDGING AND SURVEYS

THROUGHOUT THE DOMINION,

FOR THE FISCAL YEAR ENDED 30<sup>TH</sup> JUNE, 1891.

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## APPENDIX No. 3.

DEPARTMENT OF PUBLIC WORKS OF CANADA,  
CHIEF ENGINEER'S OFFICE, OTTAWA, 25th January, 1892.

SIR,—I have the honour to transmit herewith a report on the works performed in the different harbours, &c., throughout the Dominion, during the fiscal year ended 30th June, 1891.

I have the honour to be, Sir,  
Your obedient servant,  
LOUIS COSTE, *Acting Chief Engineer.*

E. F. E. ROY, Esq., Secretary, Public Works Department, Ottawa.

In No. 125938.

### PRINCE EDWARD ISLAND.

#### ANNANDALE PIER.

Annandale Pier is in King's County, and is situated on the north side of Grand River, near its entrance into Boughton Bay. It is distant 14 miles by road, south from Souris, the eastern terminus of the Prince Edward Island Railway, and is the shipping place for a large agricultural district.

The pier is not much exposed to the force of the sea, owing to the existence of a "bar" at the mouth of the river, but it is very much exposed to the running ice in the spring, and to the ravages of the teredo, which is very destructive in the river.

Since its assumption by the Department, it has received extensive repairs, principally in close-piling along the channel face.

During the last year a small amount was expended in replacing the planking on the pier head where required, in strengthening the short span in the approach, and in levelling up the approach with gravel and sand.

#### BAY VIEW PIER.

Bay View Pier is situated on the eastern side, and near the mouth of the Hope River which enters New London Harbour, about  $3\frac{1}{2}$  miles to the south-east from its entrance.

This pier is not exposed to any heavy sea, but the extreme high tide of the 1st December ult., which with the prevailing gale caused so much damage elsewhere, rose to some 18 inches above the top of the work, washed out the brush, stone and clay filling in part, leaving the structure almost unballasted, and in this condition it was partially lifted, breaking the bolts which secure the pile fenders to the work, or splitting the heads of the piles, and had it not been for the piles around the work, the structure would undoubtedly have floated off.

The work of repair, &c., consisted first in rebuilding the top of the outer end for a distance of 40 feet, to an average depth of 5 feet and in placing 14 new pile fenders around it; second in rebuilding the top on 60 feet of the pier, inside of the outer end, to a depth of 2 feet.

#### BELFAST PIER.

Belfast Pier, Queen's County, is situated on the south side of Orwell Bay, about one mile distant from the village of Eldon.

This pier is 600 feet in length and from 24 to 35 feet in width, with an L at the outer end 105 feet in length, 28 feet wide, giving a channel face of 140 feet. Excepting two small openings, the work is constructed with square timber faces, the inner end for a distance of 390 feet being filled in with brush, stone and clay, while the outer end and the L are floored over.

Since its assumption by the Department the outer end and the L, as well as the inner end for a distance of 150 feet, have been put in thorough repair.

During last season work was done in the way of renewing the top of a portion of the inner end, for a distance of 185 feet to a depth of from 2 to 3 feet, by placing

new face timbers, cross ties, longitudinals, cap and fenders, and by filling in the top with brush, stone and clay.

#### CAMPBELL'S COVE BREAKWATER.

Campbell's Cove, King's County, is situated on the north coast of the Island, about nine miles west from East Point, and 14 miles distant from Souris, the eastern terminus of the Prince Edward Island Railway.

In 1872, the Provincial Government constructed a detached breakwater 300 feet in length and 30 feet wide, on the reef which extends out from the western end of the cove, for the protection of small fishing vessels and boats.

During 1882-83 the Department repaired the old structure, raised it 2 feet in height, connected it with the shore (a distance of 70 feet), and constructed an extension thereto, 250 feet long and 20 feet wide on top, making its total length 620 feet. The whole work is constructed of square timber, the faces of the old portion, and of the connection with the shore are built plumb; the extension has a timber slope of 1 to 1 on the seaward side.

A small amount was set apart for repairing the damaged timber slope, during the last season, but the work was scarcely commenced when the place was visited by a terrific gale accompanied by an extreme high tide, which entering through the broken face, lifted the top and otherwise damaged the structure to a great extent. The amount was used in saving the materials which was scattered around the Cove.

#### CARDIGAN (NORTH) PIER.

North Cardigan Pier, King's County, is on the north side of the Cardigan River, near its entrance into the bay of the same name, and is distant about 6 miles from Cardigan Bridge, the head of navigation and a station on the Prince Edward Island Railway.

Its total length is 383 feet, and it consists of a shore abutment and seven blocks with intervening openings, the latter being spanned over and planked. It is from 23 to 25 feet wide out to the outer block, which has a width of 32 feet. The shore abutment is 100 feet in length, the blocks from 19 to 20 feet, and the spans from 14 to 26 feet long. The abutment and all the blocks are constructed with squared timber faces, filled in with brush, stone and clay, excepting the two outer blocks, which, as well as the spans, are planked over.

Since its assumption by the Dominion Government, it has received extensive repairs.

During the fiscal year four mooring posts were renewed, and the shore abutment and the blocks were levelled up with gravel and clay.

#### CASCUMPEC.

Cascumpec Harbour, Prince County, is on the north coast of the Island, about 17 miles to the southward of North Cape, and about 20 miles to the north-westward of the entrance into Richmond Bay.

The entrance into the harbour is obstructed by two bars, the outer one, composed of sand, lies about a mile from the entrance, and the "inner bar," which is composed of very soft red sandstone lies between the beaches which form the entrance. The bars are about 1,000 feet in width and carry a depth of 10 feet at low water springs, which rise 3 feet.

It is proposed to make a cut through the inner bar, 100 feet in width, with a depth of 15 feet at low water, so as to admit of a larger class of vessels to enter and leave the harbour. It is thought that a deeper channel across the "inner bar" will have the tendency to create a stronger tidal current and deepen the water over the "outer bar."

The work was commenced by the Department in 1885 by submarine blasting, and was continued every season since, but owing to the shortness of the period in which operations could be carried on, the softness of the material, which blasts badly, and the fact that the divers had to handle every piece of stone, by hand, it has not progressed as rapidly as it was expected.

During 1889-90 a new plan for the prosecution of the work was adopted and put in operation, viz., the rock was blasted, but was left in place for removal by the dredge.

On the 11th day of October ult., the dredge commenced working on the bar, and up to the 5th day of November worked 10 days and removed 1,147½ cubic yards of stone from the cut. Owing to bad weather operations had to be discontinued and the dredge was laid up for the winter.

Between the 3rd October and 8th November, 1890, the "Prince Edward" removed 1,157 cubic yards of sandstone, which had been loosened by explosives, from the bar at the entrance to the harbour.

#### CHAPEL POINT PIER.

Chapel Point Pier, King's County, is on the south side of Grand River, about 3 miles from its entrance into Boughton Bay.

The pier was constructed by the Local Government, and consisted of an approach 205 feet in length, and of a block at the end 22 feet long, they being connected by a span 22½ feet in length making the total length of the pier 244½ feet. The approach is constructed with squared timber faces and is filled in with brush, stone and clay, and the outer block is constructed with squared timber faces, but it is filled with ballast and is, as well as the span, planked over.

On the 31st day of March, 1890, a contract was entered into for repairing the top of the outer block, and for the extension of the pier, by the addition of a new block and of a new span, each being 22 feet wide and 22 feet in length, and the work was satisfactorily completed on the 9th day of August, 1890.

Besides the contract work the bottom of the old outer block which had suffered by the run of ice in the winter of 1889-90 was repaired and twenty piles were placed around it. The approach was levelled up with stone and gravel, and new top face timbers, cap and one mooring post were renewed, and its sides were strengthened by placing forty fender piles.

The pier is now 290 feet in length, and it admits of three small vessels loading at a time, instead of one as formerly.

#### CHINA POINT PIER.

China Point Pier is in Queen's County and lies on the west side of the mouth of the Orwell River, at the entrance into Orwell Bay.

The pier is 426 feet in length on the south side with a return or L along the channel face, 72 feet in length. It is from 18 to 24½ feet in width, and is composed of a series of 8 solid blocks (not including the shore abutment) with intervening openings, spanned and planked over. The shore abutment and the five inner blocks are built with squared timber faces and are filled in with brush, stone and clay. The two outer blocks and the one forming the L are also built with squared timber, but they, as well as all the openings, are covered with 3 inch plank.

In November, 1889 a contract was entered into for the removal of all flooring, cap timbers, floor stringers and span beams, the raising of the outer block and the reconstruction of the top of the L block and for levelling up the inner blocks and approach with stone and clay.

The work on the main structure was satisfactorily completed, and when the L block was stripped down to low water mark, it was found that it was too far gone to build upon.

It was then considered advisable to abandon it and to build in lieu thereof an entirely new block on the south side of the end, and all the work was completed in a satisfactory manner on the 25th November ult.

Besides the contract work 12 piles were driven around the outer block.

#### GAUTHIER'S CREEK.

At the beginning of the fiscal year the dredge "Prince Edward" was operating at Gauthier's Creek, North Rustico, improving the channel, and when the work

closed on the 17th September, 17,847 cubic yards of clay, sand and mud had been removed, and a depth of 11 feet at low water springs obtained.

#### GEORGETOWN PIER.

Georgetown, the shire town of King's County, is situated on the northern side of the Montague River, near its entrance into Cardigan Bay, and is the terminus of the Georgetown Branch of the Prince Edward Island Railway. Its harbour is well known as being one of the best and safest in the Island.

The public wharf known as Queen's Pier was constructed by the Local Government and was handed over to the Dominion Government in 1884. It is composed of a shore abutment 340 feet in length and of six blocks from 25 to 33 feet long, with intervening spans. Its total length is 642 feet and its width varies from 25 to 33 feet. The shore abutment and the blocks are built with squared timber faces, filled in with brush, stone and clay, the spaces between them being spanned over and planked.

During last season a small amount was expended in placing floor stringers and planking on the three outer blocks, and in levelling up the shore abutment, and the three inner blocks with stone and clay.

At the end of the pier there is a depth of 12 feet at low water springs. Spring tides rise 5 feet, and the class of vessels loading and discharging at the pier are large sized schooners, drawing up to 10 feet of water.

#### HICKEY'S PIER.

Hickey's Pier, Queen's County, is situated on the south-eastern side of the East or Hillsboro' River, about 10 miles distant from the city of Charlottetown.

The Hillsboro' River, being navigable for a distance of about 15 miles inland from the city of Charlottetown, is the most important river on the Island, and Hickey's Pier, since the channel at its end and berths on each side of it were dredged out by the Department, is the first in importance on the river.

The structure was constructed by the Local Government and is 428 feet in length on its centre line and is of different widths, ranging from 22 to 29 feet, the latter being the width of the outer end and for a distance of 180 feet. It is composed of a shore abutment 105 feet in length and of a series of blocks with intervening spans.

On its assumption by the Department the pier was almost a wreck, but since then it has been nearly reconstructed.

During the last session the following works were executed:—

(1.) The outer block was raised to the level of the rest of the work, and new stringers, planking, cap, 4 mooring posts and 6 fender piles were placed.

(2.) The planked portion of the shore abutment for a distance of 145 feet having settled in the centre the planking was removed, the centre stringers were raised and the planking was replaced and where necessary it was renewed.

#### HURD'S POINT PIER.

Hurd's Point, Queen's County, is situated on the south side of the southern end of Bedeque or Summerside Harbour, and about 3 miles south of the town of Summerside.

The pier is a very important shipping place, being the outlet of a large and rich agricultural district.

A channel 2,700 feet in length, 250 feet wide, with a depth of 12 feet at low water, was dredged by the Department in 1884-85, from the deep water channel to the pier.

The pier is 511 feet in length and is composed of an approach 227 feet long and 26 feet wide, the remaining length of 284 feet by 5 blocks and intervening spans. The outer block is 65 feet wide and 50 feet in length, forming a T, and it is constructed of squared timber, filled with ballast and planked over. The approach as well as the other blocks are also built with squared timber faces, but they are filled

in with brush, stone and clay. At the outer end there is a depth of 13 feet of water at low water.

During the last season a small amount was expended in renewing the planking on the outer block, where necessary, in straightening and strengthening the southern face of the approach, and in levelling up the approach and the inner blocks with stone and gravel.

#### KIER'S SHORE PIER.

Kier's Shore Pier is situated at Malpeque, Prince County, and lies on the east side of Richmond Bay, about 7 miles from Kensington, a station on the Prince Edward Island Railway.

It was constructed by the inhabitants assisted by the Local Government, and is 1,016 feet in length and from 20 to 24 feet wide. It is built with squared timber faces, filled in with brush and stone, and excepting a short span, 17 feet long, and the outer end for a distance of 25 feet which are planked, the top of the pier is covered with clay.

The amount authorized for expenditure last season was expended in filling up washouts in the roadway caused by the gale and high tide of 1st December, 1890, and in straightening up the timber faces of the inner end which had canted outwards.

#### MALPEQUE BREAKWATER.

Malpeque Breakwater, Prince County, lies within the eastern or principal entrance of Richmond Bay, on the north shore of the Island, about 90 miles from East Point and 40 miles from North Cape.

During 1877-78-79 a breakwater, 600 feet in length, was constructed by the Department on the western end of "Royalty-Sands," on the eastern side of the harbour, to shelter the anchorage from north-east winds and to afford a shipping place for the produce of the surrounding country.

Since the construction of the breakwater, the sands inside began to waste away by the action of the sea during easterly storms, and to prevent this action, a breast-work was constructed from the inner end of the breakwater to Royalty Point, a distance of 2,370 feet.

During the last season the amount authorized was expended in close-piling the outer end of the breakwater and the sides, for a distance of 10 feet from the outer end.

#### MIMINEGASH.

Big Miminegash, Prince County, is situated on the north-west coast of the Island, about 15 miles from North Cape and 18 miles from West Point.

Before its improvement, Big Miminegash was one of the numerous ponds along this coast which empty into the Northumberland Straits, through sand beaches. Being sheltered to a great extent by Miminegash Reef, a ledge of rock nearly a mile long, which lies parallel to the shore, at a distance of about half a mile, it had the advantage over the other ponds, and it was the one mostly sought by fishermen during stormy weather.

The outlet of the pond, called the "run," being through sandy soil, it often changed its course. To make it permanent and to improve the depth of water in it, it was confined to a width of 56 feet by works on either side; the Department having expended about \$9,000 since 1878.

The works consist, on the north side, of a solid timber pier 417 feet in length, and 150 feet of close piling, and, on the south side, of a pier constructed of piles, brush and stone 150 feet long.

A certain amount of work was done, consisting in re-ballasting and in the renewal of floor stringers and plank on the inner end of the north pier, for a distance of 100 feet.

## NEW LONDON.

The harbour of New London is situated on the northern coast of Prince Edward Island, about 10 miles south-east from the entrance into Richmond Bay. Within its entrance, which is about 1,200 feet wide, the bay is 3 miles wide and receives the waters of the South-West, the French, the Stanley and the Hope Rivers.

The works constructed by the Department for the improvement of the entrance into the harbour consist of a breakwater 1,050 feet in length on the sand beach at the eastern side of the entrance, built partly of piling, brush and stone and partly of cribwork, a breakwater 460 feet in length on the beach at the western side of the entrance, the inner end for a distance of 400 feet consisting of pile, brush and stone work, and the outer end being a squared timber block.

During the last season the amount authorized was expended in the construction of a cribwork block 102 feet in length, between the two outer blocks of the eastern breakwater, and in extending this breakwater at the inner end a distance of 82 feet by the construction of a breastwork composed of piling, brush and stone.

## PINETTE PIER.

Pinette Harbour, Queen's County, is on the north side of the Northumberland Strait, 4 miles east of Point Prim, and 12 miles north of Wood Islands. It is situated at the mouth of Pinette River and extends about  $2\frac{1}{2}$  miles inland to Pinette Bridge, the navigable channel being from 200 at the upper end to 600 feet wide at the lower end, and carrying a depth of water of 3 fathoms at low water springs, which rise 8 feet.

A pier 120 feet in length and 28 feet wide was built on the south side of the channel, below and at right angles to Pinette Bridge and connected with the bridge by a span 28 feet long planked over.

The pier is built along the channel and has a frontage including the span of 148 feet. During 1881 the dredge "Prince Edward" operated here in deepening the loading berth off the face of the pier to a depth of 8 feet below low water springs.

During the past season the work done consisted in placing 16 fender piles along the channel face, 16 piles in the centre of the work to keep it from sliding out, and in placing new plank on top where necessary.

## PORT SELKIRK PIER.

Port Selkirk Pier, Queen's County, is on the south side of the mouth of the Orwell River, at its entrance into Orwell Bay.

The pier was constructed by the Local Government, and is in the form of a T, its length from the shore to the channel face being 252 feet, and the length of the pier-head 200 feet, the width of the approach is 23 feet and that of the pier-head 35 feet.

The pier-head was originally 250 feet in length on the channel face, but as the upper block was in danger of tumbling into the channel it was removed, together with the span connecting it with the next block, and thus the length was lessened by 50 feet.

During last autumn temporary repairs were made to the lower end of the pier, so as to render it available for traffic.

On 25th February ult. a contract was entered into for the construction of a block and span at the upper end of the pier, and at the end of the fiscal year the work was about half completed.

## POWNAI PIER.

Pownal Pier, Queen's County, is situated at the head of Pownal Bay, the north-eastern corner of Hillsboro' Bay, and is distant about 9 miles from the city of Charlottetown.

The pier was built by the Local Government and is 753 feet in length. It consists of a shore abutment, 209 feet in length and 16 feet wide, and of 14 blocks

intervening spans. The inner blocks are from 16 to 18 feet wide, and the two outer are 40 feet wide.

The limit of boats and small craft coming to and leaving the pier at all times is the Department, during 1880-81, dredged a channel up to the pier 1,275 feet long, 30 feet wide and from 5 to 6 feet in depth, carrying a depth of from 6 to 10 feet of water at low water springs, and a basin on the eastern side of the end of the pier 100 feet wide and 250 feet in length.

During the past season a small amount was expended in building up the shore abutment and the blocks with stone and clay, which had been washed out by the storm of 1st December, 1890.

#### RED POINT PIER.

Red Point Pier is in Queen's County, and is situated on the eastern side of the Red River, about 6 miles north-eastwardly from the city of Charlottetown.

The pier is 650 feet in length, 21 feet in width and is 12 feet high at the outer end, and 10 feet at low water, but as the Department during 1888-89 dredged a channel deep water channel of the river to the end of the pier, carrying 12 feet at low water, vessels are now enabled to load at it at all times of tide.

The pier is composed of a shore abutment 310 feet in length and of 5 inner blocks from 29 to 75 feet in length, with intervening spans from 21 to 25 feet in width. The shore abutment and the blocks are filled in with brush, stone and water blocks as well as the openings are planked over.

During last fall work was carried on of renewing the top of the shore abutment to a average depth of 3 feet, in fendering it every 10 feet, in placing new span blocking and cap on the three inner openings, in placing 5 fender piles on each of the four inner blocks, in placing four mooring posts in the corners of the pier block, and in levelling up the top of the shore abutment and of the four inner blocks with stone and clay.

#### RUSTICO (NORTH) BREAKWATER.

North Rustico, Queen's County, is the most important fishing station on the north-east of the Island, and is nearly equidistant from North Cape and East Point.

During the years from 1881 to 1884, the Department constructed breakwaters across the entrance to the harbour for the purpose of concentrating the ebb and flood upon the "bar" outside, so as to scour away the sand and thus obtain a greater depth of water over it. The results have been most satisfactory, as the depth of the bar has been increased by 3 or 4 feet, which, added to the former depth, has at present at low water springs from 9 to 10 feet of water, and at high water from 12 to 15 feet.

The breakwater on the north side of the entrance, is the most important and measures 1,240 feet in length, but as the outer end was badly damaged, it was reconstructed for a distance of 17 feet. The inner end of the breakwater for a distance of 100 feet is constructed of piles, brush and stone, the outer end is close faced timber on a pile and plumb on the seaward side up to a height of 2 feet above low water and above that level, with a slope of 1 to 1 the inner face is built with a batter of 1 in 4. The width of the outer end is 9 feet wide, and it as well as the sloping face are covered with plank. The bottom of the sloping face is close-piled.

During last autumn, the outer end for a distance of 20 feet was reconstructed, and on the bottom of the sloping face was replaced and the piles on the sloping face and on the top was renewed where necessary.

The work was visited by the terrific gale of 1st December, 1890, accompanied by extreme high tide, and the outer end of the breakwater for a distance of 100 feet sustained severe damages. During the spring the most urgent repairs were made upon the structure, but owing to the stormy weather prevailing during the latter part of June they could not be accomplished by the end of the fishing year.

#### RUSTICO (SOUTH) PIER.

South Rustico Pier, Queen's County, is situated immediately below the Oyster Bed Bridge at the mouth of the Wheatley River, which enters Rustico Bay, at its southern end. It is distant about six miles from Hunter River Station on the Prince Edward Island Railway, and about 13 miles to the northward of the city of Charlottetown.

The pier was constructed by the Local Government to accommodate the shipping of produce from and the importation of coal and lumber to the locality. It is 593 feet in length and consists of a shore abutment 450 feet long and  $17\frac{1}{2}$  feet wide, and of three detached blocks about 25 feet apart. The inner block is 17 feet wide and  $23\frac{1}{2}$  feet long, the two outer blocks are respectively 29 and 30 feet wide and 20 and 24 feet in length. The approach or shore abutment and the blocks are built of square timber, filled in with brush, stone and clay, the outer block and the spans are covered with plank.

During the last autumn, a small amount was expended in levelling up the top of the shore abutment and blocks with broken stone.

#### ST. MARY'S BAY PIER.

St. Mary's Bay Pier is situated on the south side of St. Mary's Bay, which forms the extreme southern end of Cardigan Bay, and is about 6 miles south of Georgetown, the shire town of King's County.

The pier is 407 feet in length and for a distance of 310 feet is 21 feet wide, the outer end for 97 feet being from 28 to 29 feet in width. It is composed of a shore abutment and of 7 blocks with intervening spans.

During the past season the western face of the shore abutment was repaired, and the roadway levelled up with stone and clay.

#### SOURIS BREAKWATER.

Souris Harbour, Colville Bay, King's County, is about 16 miles to the westward of East Point, the eastern extremity of the Island. It is a very important shipping port and is the eastern terminus of the Prince Edward Island Railway which has a deep water wharf here.

The anchorage being good and safe with all northerly winds, the Department constructed a breakwater from the end of the one previously built by the Local Government off Knight's Point, on the eastern side of the harbour, to afford shelter during southerly gales and thus form a harbour of refuge. This breakwater is 1,180 feet in length, including the portion constructed by the Local Government, which is 270 feet long. This portion is 25 feet wide with faces plumb; the centre portion is 500 feet in length and 46 feet wide with faces plumb, and the outer section is 410 feet in length and  $21\frac{1}{2}$  feet wide on top, with sides sloping 1 in 6.

It is exposed to the full force of the sea during southerly gales, and to the attacks of the teredo, which is very destructive in these waters, and since its construction it has required partial reconstruction and very extensive repairs. The outer end stands in 24 feet of water at low water springs, and being rather narrow for its height (21 feet wide on top and 30 feet high) the top was moved some 3 feet inward by the force of the sea. To protect its weakened face on the seaward side, a heavy stone slope was commenced by the Department during 1888, and at the same time a strongly constructed timber block 30 feet square on the bottom, and close piled all around, was placed on the outer end of the seaward face to prevent the stone from moving around it.

The placing of heavy stone along the seaward face of the outer section has been carried on yearly since, on a limited scale, and it will take several years before the slope is completed, as every successive gale tends to scatter the stone, but when this has obtained a natural slope, the sea will no longer have any effect upon it.

During the last season the sum of \$3,699.82 was expended in reconstructing the top of the outer section for a distance of 310 feet, by placing new ballast floors,

ballast to a depth of about 6 feet, new floor stringers, cap, flooring and fender piles. The seaward face of the section was strengthened by a deposit of about 1,200 cubic yards of large quarried stone.

On 1st December, 1890, this work was visited by a terrific gale accompanied by an extreme high tide, but the stone on the seaward side of the outer section broke up the seas before they reached the breakwater, and prevented serious damage.

#### STEVEN'S PIER.

Steven's Pier is at Montague, King's County, and is situated on the southern side of the Montague River, immediately below Lambert's Pier, and six miles above its entrance into Cardigan Bay.

Since the improvement of the navigable channel of the river by the Department, vessels of considerable size can ascend the river up as far as Montague Bridge, where a large amount of produce is yearly shipped.

The pier consists of two wings, about 50 feet apart, extending out from the shore with a pier-head at the outer end 100 feet long, along the channel. The wings consist of shore abutments 90 and 115 feet in length respectively, built with squared timber faces and filled in with stone and gravel, next of openings 21 and 30 feet in length, spanned and planked over, square timber blocks form the outer end of the wings. The pier-head is constructed on pile bents, spanned and floored over.

On the assumption of this pier by the Department, the pier-head was reconstructed and the weakest portions in the approach were repaired.

During the past season the greater part of the pier-head and spans were replanked, fender piles were placed on the outer face of the eastern shore abutment, stone was placed against the inner face of both shore abutments, and the approaches were levelled up with broken stone.

#### STURGEON PIER.

Sturgeon Bay, King's County, is situated on the south side of Cardigan Bay, about six miles south of Georgetown, the terminus of the Georgetown Branch of the Prince Edward Island Railway.

The pier was constructed by the Local Government to accommodate the shipping of produce from the locality. Its total length is 436 feet, and is from 20 to 25 feet in width, its height at the outer end is 13 feet, with a depth of 4 feet at low water springs, which rise 5 feet. It consists of a shore abutment 250 feet in length, and four blocks of from 20 to 25 feet in length, with intervening spans of from 22 to 25 feet long. The faces of the approach and blocks are constructed of squared timber, filled in with brush, stone and clay. The two inner openings are filled in with brush at the bottom, and with stone and clay on the top, the sides above the brush being timbered up to keep the stone and clay in place. The two outer openings and the outer block are covered with plank.

During the last season a small amount was expended in levelling up the approach and the top of the blocks with broken stone, in replacing five fender piles and one mooring post, and in renewing some plank on the spans and the outer block.

#### VICTORIA PIER.

Victoria is a thriving settlement in Queen's County, situated at the head of navigation in Crapaud Basin. It is about 11 miles south of Emerald Junction, a station on the Prince Edward Island Railway, and is about halfway between the towns of Charlottetown and Summerside.

The Government Pier, so called to distinguish it from other wharves owned by private parties, has a total length of 486 feet. The approach is 268 feet long and 20 feet wide; the next section 143 in length has an average width of 37 feet, and the outer 75 feet has a width of 58 feet, so that a large area is available for top wharfage. Its height at the outer end is 19 feet, with a depth of water of 15 feet at high

tides. With the exception of the approach, which is built solid, the work is composed of blocks and spans.

The approach from deep water outside to the wharves has been of late years much improved by dredging.

During last fall the planking on the middle and the outer sections was removed and 50 new floor stringers, 8,150 sup. feet of new 3-in. plank and 2 mooring posts were placed on the work, besides the approach was covered to a depth of 15 inches with stone, and the faces were repaired where necessary.

## NOVA SCOTIA.

### BARRINGTON.

Barrington, Shelburne County, is distant 45 miles to the south-east of Yarmouth and 30 miles south-west from the town of Shelburne, and is within 10 miles of Cape Sable, the most southerly point of Nova Scotia.

Barrington owes its importance almost entirely to the fishing industry, and not only does considerable shore fishing, but annually fits out and supplies a number of schooners for the Bank fishery. It is a port of call for the line of steamers running between Halifax and Yarmouth, and is the northern terminus of the steam ferry to Cape Sable Island. Owing to the increasing trade in the fresh fish and lobster business a line of local steamers now makes four trips a week between Barrington and Yarmouth, calling at intermediate ports and fishing stations.

Until the present year the only wharf at Barrington at which steamers could land their freights was a private one at the lower part of the Passage, from which the ferry runs to Cape Sable Island. This wharf is not accessible at low water owing to a bar (distant about 1,200 feet from the end of the wharf), on which there is only 4 feet of water at low tide.

An examination was made by the Department in 1888 to ascertain the most suitable site for a public wharf, and one was selected near the head of Sherose Channel as being the most central and sheltered and at the same time having a sufficient depth of water.

The construction of the wharf was begun in 1888-89 and continued during the following year.

During the past year the wharf has been completed.

It consists of first an inshore section, 90 feet long, built entirely of stone; secondly, 135 feet of cribwork to the beginning of the soft mud flats; thirdly, 750 feet of pile wharfing to the edge of the channel, and lastly, an L 70 feet long along the face of the channel, for steamers to lie at. The first three sections are 20 feet in width, and the L or channel portion has a width of 30 feet.

The channel block is furnished with a movable "drop" or landing, to enable vessels to discharge freight readily at all times of tide, and also with a substantial warehouse 19 feet by 35 feet, for receiving and storing freight.

As the fishing schooners which are usually wintered afloat in Sherose Channel would interfere with the movements of the steamers if allowed to remain at anchor there, five good berths have been provided for them along the sides of the wharf. These berths are fitted with pile fenders, mooring posts, rings, &c.

Bunches of piles or "dolphins" have been driven on the flats to mark the bends of the channel, and the whole work is now complete and in thorough working order.

### BROAD COVE.

Broad Cove Marsh, Inverness County, is on the Gulf of St. Lawrence, 12 miles south from Margaree Harbour.

A wharf, 400 feet in length and 25 feet in width on top, was completed in 1888. The depth at the outer end, at extreme low water, is 12 feet 10 inches. Spring tides rise 4 feet 5 inches.

In 1889 the ballast was washed out of eight chambers or spaces between the cross ties on the north side of the wharf, and several of the upper face timbers on the south side were loosened.

During the year 1890-91 a small amount was expended in replacing and securing with extra bolting the upper face timbers on the south side, and in placing vertical pieces close together against the face timbers in six chambers on the north side, and refilling to within 4 feet of the covering with stone ballast.

#### BRULÉ.

Brulé is situated on the south side of Brulé Harbour, Northumberland Strait, in the extreme north-east corner of Colchester County, about midway between River John and Tatamagouche, and is distant about one mile from Denmark station, on the Oxford and New Glasgow branch of the Intercolonial Railway, shortly completed.

The wharf is about 400 feet in length, with an average width of  $23\frac{1}{2}$  feet, built entirely of round timber, excepting the top face timbers, the floor stringers and the cap. For a distance of 300 feet from the inner end the top is gravelled, the outer 100 feet are planked over. The work is 14 feet high at the outer end, and the depth of water at the same place, at low water springs, is 3 feet, and as spring tides rise 8 feet the depth at high water springs increases to 10 feet.

The top of the work was much damaged by the heavy gale of the 1st December ult., which was accompanied by a tidal wave which rose some 5 feet above the level of an ordinary spring tide, and during the spring the necessary amount was expended in replacing floor stringers, planking and cap, and three fender piles at the outer end for a distance of 100 feet, in renewing the top of the work inward of the outer portion for a distance of 90 feet to a depth of 3 feet, and in replacing stone and gravel to a depth of 2 feet on the inner end of the wharf.

#### CARIBOO.

Cariboo Island, Pictou County, is on the Northumberland Strait, 5 miles to the westward of the entrance to Pictou Harbour. It is about 4 miles in length and half a mile in average width.

Cariboo Harbour, sheltered by Cariboo Island and a smaller island lying to the eastward of it, is an extensive place, 6 miles in length and 1 mile in width, occupied by shallow water. The principal entrance, between the two islands, has only 4 feet at extreme low water, and the flats between the mainland and the western extremity of the Cariboo Island are dry at extreme low water except in a few small channels. Spring tides rise 6 feet, neaps 4 feet.

With the amount authorized a work of brush and stone 1,221 feet in length, 19 feet in width on top, and from 2 to 5 feet in height was constructed between the island and the mainland. It is still in an unfinished condition, being covered at about half-tide.

#### CHETICAMP.

Cheticamp Harbour, Inverness County, is on the west coast of Cape Breton Island, 18 miles north from Margaree Harbour.

It is a secure harbour, being sheltered from the west and south by Cheticamp Island and a connecting beach. The entrance is from the north, through a dredged channel.

During the summer, regular steam communication is maintained between Pictou and intermediate ports.

During the year 1890-91 a contract entered into 10th June, 1889, for the construction of a wharf on the eastern side of the harbour, was completed. This wharf consists of an approach 125 feet in length and 30 feet in width, over a distance of 60 feet from its outer end, with side walls and centre filling of stone, and an extension 80 feet in length, in two blocks with openings of 17 feet 6 inches. The outer block is 60 feet in length along the channel face and has a depth of 11 feet at extreme low water. Spring tides rise  $3\frac{1}{2}$  feet.

The "Geo. McKenzie" operated at this place between 22nd September and 7th November, 1890, and from 3rd June, 1891, to the close of the fiscal year, in widening and deepening the channel, which is now 40 feet wide, with a depth of 14 feet at low water springs.

#### CHURCH POINT.

Church Point, Digby County, is one of the most important shipping places on the south side of St. Mary's Bay. It is nine miles south from Weymouth and directly opposite Petit Passage, Digby Neck.

During the last few years the gravel has been working around the outer end of the breakwater and forming a bar across the entrance to the loading berths. To prevent further movement of the gravel, the Department, during the past fiscal year, built an L or spur, 40 feet long and 24 feet wide, at the north-west corner of the breakwater.

#### COW BAY.

Cow Bay, Cape Breton County, is on the eastern coast of Cape Breton Island, about 18 miles north-east of Sydney Harbour. Owing to the extensive coal mines in its vicinity it is a place of considerable importance.

The bay is  $2\frac{1}{2}$  miles wide at its mouth, and being completely open to the Atlantic Ocean affords no safe anchorage during easterly gales.

A breakwater was built some years ago, on the north side of the bay, by Messrs. Archibald & Co., proprietors of the Gowrie mines, with some aid from the Government of Nova Scotia. It is 1,386 feet in length and was originally about 44 feet in width, with a depth at the outer end, at low water, of 20 feet. The area of the basin enclosed between it and the loading pier of the Gowrie mines, is about 17 acres, 10 acres of which had originally a depth of from 9 to 20 feet at low water. Spring tides rise 5 feet.

Extensive repairs have been made nearly every year, and the work has been strengthened by the addition of counterforts and outer face works, and by close-piling.

The breakwater now consists of an inner work extending from within 220 feet of the shore end to the outer end, with counterforts and connecting works on the seaward side, from within 580 feet of the shore end to the outer end. The outer and inner works are from 20 to 25 feet apart, they are connected at intervals by tie-walls and the spaces are filled with earth and stone ballast.

During the year 1890-91, the amount appropriated was expended in completing the close piling of the inner face from within 560 feet of the inner end to the outer end, in repairing the covering, and in close-piling and other repairs to the outer face works.

#### CRIBBIN'S POINT.

Cribbin's Point, Antigonish County, is on the west side of St. George's Bay, 3 miles south from Cape George, and 5 miles north from the entrance to Antigonish Harbour.

During the year 1890-91, a contract was entered into for the construction of a wharf to extend 300 feet in a southerly direction from the point, to 11 feet at extreme low water, with an approach 195 feet in length. The wharf is to be 20 feet in width, on top, over a distance of 120 feet from the inner end and 30 feet in width on top over the remaining 180 feet. The inner 50 feet is to be of stone, with stone retaining walls, and the outer 250 feet of close faced timber work, full ballasted and protected by sheathing and fenders. The approach is to consist partly of side cutting and embankment with stone retaining wall, and partly of through cutting 18 feet wide at the bottom with sides sloping  $1\frac{1}{2}$  to 1. Spring tides rise 4 feet.

At the close of the year the through cutting of the approach was nearly completed. There was in place 45 feet of the retaining wall of the approach averaging 8 feet in height, and 40 feet of side walls of the shore end of wharf averaging  $4\frac{1}{2}$  feet

weight and there had been delivered a large quantity of timber, and nearly all the work required.

#### DELAPE COVE.

Delape Cove is situated on the south shore of the Bay of Fundy, in Annapolis County, and is about 12 miles to the eastward of Digby Gut.

The spar buoy and anchor which had been placed by the Department to the east of the outer end of the breakwater, having been carried out of its position by a heavy storm, was replaced during the present year, and the spar, which was old, was renewed.

#### DIGBY.

The town of Digby is situated at the western end of the Annapolis Basin. It is the eastern terminus of the Western Counties Railway, and during the past year has been connected by rail with Annapolis and the general railway system of Nova Scotia.

Owing to the dilapidated state of the present Digby pier, &c., the limited depth of water at its site, it was considered advisable to construct a new pier in deep water to meet the increasing railway and steamboat traffic of the port, and at the session of Parliament an appropriation of \$40,000 was made for this purpose.

The site selected for the work is about  $\frac{1}{2}$  mile to the northward of the present pier on the opposite side of the "Raquette," and a contract for its construction was given in November last. Owing to difficulties the contractor has had to contend with the actual construction has not yet been begun, but a considerable amount of material for the work has been delivered near the site.

The proposed work is to be 750 feet long, 50 feet wide on top, and will extend to 16 feet of water at low tide. All its exposed faces are to be constructed of squared timber, birch being used for the lower portions to within 18 feet of the top. The pier is intended to meet the requirements of both the railway and steamboats and will be provided with inclined landings and other improvements, so that freight can be handled at all stages of the tide with as little delay as possible.

Pending the construction of the new pier, the steamers calling at Digby can make use of the old steamboat pier, and during the past fiscal year the Department repaired the inclined landing of this latter work. The repairs consisted of some additional ballast, new floor stringers, retfastening some of the old stringers and replacing the broken covering with new timber.

#### ECONOMY.

Port of Call, Colchester County, is situated on the north side of the Basin of Minas, about 10 miles to the westward of Great Village and 20 miles east from the town of Parrsboro. It is the Bay of Fundy terminus of the Cumberland Coal and Railway Co.'s R.R.

A wharf to serve the purpose of a breakwater, 208 feet in length and 25 feet in width on top, was constructed by the Department during 1887-88.

During 1889-90 the pier was extended 100 feet, and an L 25 feet in length was added on the eastern side of the outer end. The work on the extension, through the exception of cap-timbers, floor stringers, fenders and covering, was constructed in the same manner as the original pier. All faces are double fenders, two ballast floors were placed on it, and a third ballast to depths of 4 and 3 feet respectively has been placed. Sixteen ring bolts and two ladders were also placed and secured.

The amount appropriated has been expended in the extension of the wharf a distance of 100 feet, constructed in a similar manner as the work done in 1887-88. The total length of the work is now 408 feet, with a depth of 16 feet of water at its outer end at high water springs, which rise here 46 feet. No work was done in 1890-91.

## FOX ISLAND.

Fox Island, Halifax County, is situated on the Atlantic coast of Nova Scotia, about 15 miles to the eastward of Halifax, and lies about 800 feet distant from the mainland.

Until 1879 it was connected with the mainland by a shingle and gravel bar, which being bare at all times of tide was used as a road for carts, hauling water, supplies and stores to the island. Besides serving as a road, the beach with the island formed a harbour for fishing boats. During the early part of 1880, the sea broke through the beach, and these inroads continued until 1885, when it ceased to afford shelter and to serve as a means of communication with the mainland.

To restore its usefulness, during the year 1886-87, the Department constructed beach protection works, extending over the whole length of the beach, a distance of 935 feet. The work consisted of round timber cribwork, with a batter of 1 in 4 on the sides, 13 feet wide on top, and with a stone slope of 2 to 1 on each side, extending up to 2 feet below the top. The whole of the cribwork was filled in with stone up to the level of the top timbers.

Since its completion the beach made up on each side of the work up as high as the work itself, but during the gales of last autumn, the made up beach on the east side for a distance of 190 feet was washed away, and the ballast on the top of the work for the same distance and 2 feet in depth, and for a width of 5 feet, was washed out, and this ballast has been replaced.

## FRENCH RIVER.

French River, Victoria County, is on that part of the east or Atlantic coast of Cape Breton Island known as the "North Shore," midway between the harbours of St. Ann's and South Ingonish.

During the year 1890-91 a contract was entered into for the construction of an isolated breakwater, 50 feet in length and 27 feet in width on top, to be placed in from 6 to 7 feet at extreme low water. Spring tides rise 5 feet.

Up to the 30th June nothing had been done, except in the way of procuring materials.

## GEORGEVILLE.

Georgeville, Antigonish County is on the Northumberland Strait,  $6\frac{1}{2}$  miles south-west from Cape George, and distant by land from Arisaig on Northumberland Strait and McNair's Cove on St. George's Bay, 8 miles.

During the year 1890-91, a contract was entered into for the construction of a wharf 230 feet in length and 20 feet in width on top, with an L 20 feet by 20 feet to consist of an approach 110 feet in length of stone, with stone retaining walls, and an outer work of squared timber, close faced and fully ballasted.

At the close of the year 45 feet of the approach had been built, and there had been delivered a small quantity of the timber and nearly all the iron required for the outer work, as well as nearly all the stone for the remainder of the approach.

The depth at the outer end of the wharf at extreme low water will be 5 feet. Spring tides rise 4 feet.

## GREAT VILLAGE.

Great Village, Colchester County, is situated on the north side of Cobequid Bay and on the Great Village River, about  $1\frac{1}{2}$  miles from its entrance into the Bay. It is distant about 15 miles north-west from Truro, the shire town of the county and the head of Cobequid Bay, and  $3\frac{1}{2}$  miles from Londonderry Station on the I. C. R.

For the accommodation of the inhabitants of the locality, during the last session of Parliament an appropriation was made for the construction of a public wharf immediately below the village, the proposed structure being 70 feet long and 70 feet wide, with a depth of 15 feet of water along its river face during spring tides, and a contract was entered into by the Department, on 19th January, 1891, for the construction of the wharf. At the end of the fiscal year the old wharf on the site had been taken down and a fair start made with the new work.

## HAMPTON.

Hampton, or Chutes Cove, Annapolis County, is on the south side of the Bay of Fundy, about 25 miles east of Digby Gut.

In February, 1889, during a heavy freshet the brook which empties into the Bay immediately to the eastward of the breakwater tore away its banks and the gravel beach and threatened to undermine the breakwater.

During the past fiscal year a small sum was expended in repairing the damage, and in turning the brook into its original channel.

## HARBOURVILLE.

Harbourville, King's County, is on the south shore of the Bay of Fundy, about 55 miles east of Digby Gut.

During the past fiscal year some small but necessary repairs were made to the breakwater. These repairs consist of replacing and fastening some 41 new pieces of sheathing on the seaward face of the breakwater, some slight repairs to the "break," and reballasting a portion of the work where the covering had worked loose, and securing this latter again in position.

## IRISH COVE.

Irish Cove, Cape Breton County, is on the south-east shore of the Great Bras d'Or Lake, near the entrance to East Bay. The distance to the head of East Bay is 20 miles, to St. Peter's Canal about 22 miles and across the lake to Grand Narrows 10 miles.

During the year 1890-91 a part of the amount appropriated was expended in procuring material for, and in the partial construction of, a wharf extending 162 feet to 12 feet at the lowest lake level. The difference between low and high lake level is 15 inches.

The wharf will consist of a shore block 49 feet 6 inches by 20 feet, a central block 20 feet by 20 feet, and an outer block 57 feet 6 inches by 20 feet with an L 20 feet by 20 feet, with two openings of 17 feet 6 inches each.

## JOGGINS BREAKWATER.

Joggins Harbour, Cumberland County, is situated on the south-eastern side of and near the head of the Chignecto Channel, the north-east arm of the Bay of Fundy. It is the terminus of the Joggins Railway and the shipping place for the coal from the Joggins Mines to points on the Bay of Fundy.

The works consist of a loading pier about 160 feet in length and 65 feet wide, and a breakwater 280 feet in length and 20 feet wide on top, running nearly parallel to the shore, to which it is connected by an approach 145 feet in length and from 16 to 20 feet in width.

The sheltered area inside of these works is about one acre in extent and can only be entered at three quarter flood. Tides rise here about 35 to 41 feet, and the flats dry at low water out to a distance of about a quarter of a mile outside of the breakwater.

During the fiscal year extensive repairs and renewals were made on the breakwater.

## JORDAN BAY BREAKWATER.

Jordan Bay, Shelburne County, is on the Atlantic coast of Nova Scotia, about midway between Shelburne and Lockeport.

In 1875 a breakwater 550 feet long was built on the eastern side of the bay, about 6 miles from its mouth, to give shelter to vessels resorting here to load lumber, a considerable quantity of which is cut on the Jordan River which falls into the head of the bay.

Some slight repairs were made to the work during the past fiscal year; a portion of the plank covering and sheathing having been torn off during a heavy storm was replaced.

#### KENNINGTON COVE.

Kennington Cove, Cape Breton County, is on the north side of Gabarus Bay, about 5 miles to the westward of the entrance to Louisburg Harbour.

During the year 1890-91 the amount appropriated was expended in improving by the removal of rocks and boulders, the landing place for boats at White Point, one mile to the westward of the entrance to Louisburg Harbour.

#### LISMORE.

Lismore, Pictou County, is on the Northumberland Strait, 10 miles to the eastward of the entrance to Merigomish Harbour, and the same distance from Merigomish Station on the Eastern Extension of the Intercolonial Railway.

A wharf was commenced by the Department in 1886-87 and completed the following year. It is 200 feet in length and 20 feet wide, strongly constructed, full ballasted and close fendered at the outer end. The depth at extreme low water at the outer end is 1 foot 9 inches. Spring tides rise 4 feet 6 inches.

During the year 1890-91 material for a proposed extension 200 feet in length to 6 feet at extreme low water was procured, and 150 feet was built up to about 2 feet above extreme low water, and full ballasted.

#### LITTLE BROOK.

The Little Brook Wharf, Digby County, is situated on the southern shore of St. Mary's Bay, about 3 miles to the southward, and westward of Church Point.

During the past season \$100 was expended in repairing the upper portions of the wharf which were considerably damaged by a very high tide in the autumn of 1890, a portion 20 feet square and 5 feet deep was rebuilt, and 100 tons of additional ballast placed in the work.

#### LOBSTER ROCKS, YARMOUTH HARBOUR.

The Lobster Rocks in Yarmouth harbour are on the western side of a sharp bend in the channel immediately below the steamboat wharf and in front of the marine railway.

Owing to the narrowness and crookedness of the channel these rocks have always been a source of danger to steamers and other vessels leaving the harbour on an ebb tide. Some years ago the inner portions of these rocks were covered with a cribwork block built at the expense of the local authorities.

It has several times been proposed to remove the outer portion of the rocks by blasting and dredging but, after careful surveys and examinations, the estimated cost was found to be so large that it was finally decided to build a second cribwork abutment a short distance outside the old one, so that it would be impossible for vessels to strike or ground upon them; and in August last an appropriation was made for this purpose.

The work was completed during the past fiscal year and has already proved of great service, on one occasion saving the new iron steamer "Boston" from serious injury.

The block is sunk in from 8 feet to 12 feet of water, at low tide, and is 22 feet square on top, its sides are built with a batter of 1 foot in 8 feet and the four sides sheathed with hardwood plank and the corners protected with heavy fenders and iron straps.

#### MABOU.

Mabou Harbour, Inverness County, is on the west coast of Cape Breton Island, 6 miles north-east from Port Hood.

The entrance was formerly at the southern extremity of a range of sand hills, by an intricate channel obstructed by a bar, over which there was a depth of only 4 feet at low water.

In 1870, a survey was made and a report submitted on the project of opening a new channel through the sand hills, at their northern extremity, and closing the existing channel.

The work was commenced in 1872. A pier on the south side of the new channel, 753 feet in length, was completed in 1876, and the same year the old channel was closed. Expenditures have been made nearly every year since 1876, in constructing a brush and stone dam on the south side near the outer end of the pier, constructing and repairing a breastwork on the north side, and since 1885, in constructing a work of brush and stone in shoal water on the south side of the channel extending 1,087 feet beyond the outer end of the pier.

The new channel is straight and in every way a great improvement on the former entrance, which is now closed by a sand bar from 900 to 1,000 feet in width. The depth at low water in the new channel, over the bar opposite the outer end of the brush and stonework, was, at the close of the year, about 6 feet. In the channel, from the outer end of the brush and stonework to the outer end of the pier, the depth varied from 8 to 12 feet, and opposite the pier where it is about 100 feet wide, from 12 to 15 feet, at low water. From the inner end of the pier there is a channel 4,000 feet in length, expanding into a fine basin  $2\frac{1}{2}$  miles long and from a quarter to half a mile wide inside the 10 feet lines, and having a depth of from  $2\frac{1}{2}$  to 4 fathoms over a large part of its area.

During a succession of gales in December last, a portion of the pier on the south side of the channel 280 feet in length (80 to 360 feet from the outer end) was destroyed. The breastwork on the north side of the channel was destroyed several years ago.

The amount appropriated for the year 1890-91 was expended in the construction of a brush and stone dam 250 feet in length and 10 feet in width, on the south side of the channel between the outer end of the pier and the sand hills, and in raising the brush and stone extension nearly to high water level from end to end.

At the commencement of the fiscal year, the "Canada" was working at this place alongside the breakwater and at the site of a proposed wharf, work being closed on 10th November, 1890, at which date 20,700 cubic yards of material had been removed.

#### MARGAREE.

Margaree Harbour, at the mouth of the Margaree River, Inverness County, is on the west coast of Cape Breton Island, about 30 miles north-east of Port Hood. It has a narrow and intricate channel through which the tides run at the rate of 4 knots, and its entrance is obstructed by a bar of shifting sand, over which there is at times a depth of only 5 feet at extreme low water. Spring tides rise 4 feet.

A pier constructed on the west side of the entrance to the harbour by the Provincial Government prior to Confederation, was repaired and extended by the Department in 1876 and again in 1879.

During the year 1890-91 a contract entered into in 1889 for repairs to the pier, and for an extension 200 feet in length, was completed, and some repairs to the old work, not included in the contract, were effected. The extension is 20 feet in width on top over a distance of 170 feet and 25 feet over the remaining 30 feet. It is of round timber, full ballasted and close fendered.

#### MARGARETVILLE.

Margaretville, Annapolis County, is on the south shore of the Bay of Fundy, about 42 miles east of Digby Gut.

The breakwater, which was built by the inhabitants many years ago, was badly damaged by storm in December, 1885. The work was repaired by the Department in 1887-88, at which time a section 150 feet long of the inshore end was rebuilt.

In October last a succession of heavy gales tore away the beach near the outer end of the work and having exposed the decayed and worm-eaten foundation soon made a breach directly through the breakwater.

An appropriation of \$400 was immediately made to save the work from further damage during the coming winter's storms, both ends of the breach were bulkheaded up, some of the wreckage was removed and all timber that was fit for further building operations was saved and piled above the reach of tide water.

#### MERIGOMISH.

Merigomish Harbour, Pictou County, is on the Northumberland Strait, 10 miles to the eastward of the entrance of Pictou Harbour. The depth at low water over the bar at the entrance is 14 feet. Spring tides rise  $5\frac{1}{4}$  feet, neaps,  $3\frac{1}{4}$  feet.

In 1880, a wharf was built by the Department in a cove to the eastward of Hard Wood Point, and about 1 mile from Merigomish Station on the Eastern Extension of the Intercolonial Railway. It is 154 feet in length and 20 feet in width, on flats dry at extreme low water to the outer end and, consists of an approach 70 feet in length, of earth with stone side walls, and 84 feet of block and span work with covering.

During the year 1890-91, the covering over 65 feet of the outer end of the wharf was renewed.

#### METEGHAN RIVER.

Meteghan River falls into St. Mary's Bay about 2 miles north-east of Meteghan Cove and 9 miles south of Church Point.

The harbour is formed by two breakwaters, one on either side of the river mouth, both of which were built many years ago by the Provincial Government. These works have been extensively repaired and otherwise improved by the Department on several occasions.

During the past fiscal year an expenditure was made by the Department in the removal of some rocks from the channel which interfered with the keels of vessels when lying at the wharf, and also in effecting some slight repairs to both breakwaters.

#### MOIDART.

Moidart, Antigonish County, is on the Northumberland Strait, 3 miles west from Arisaig.

In 1887-88 a landing place for boats was made by levelling off the top of a large rock and constructing a narrow approach 73 feet in length of stone, with cribwork top. The approach was destroyed during a succession of northerly gales in October, 1890.

The remains of the old work have been removed and a new approach 75 feet in length, 16 feet in width and 6 feet in average height, constructed of round timber, full ballasted, covered and fendered.

The depth at extreme low water at the east side of the rock is 2 feet. Spring tides rise 5 feet.

#### M'NAIR'S COVE.

McNair's Cove, Antigonish County, is on the west side of St. George's Bay, about  $1\frac{1}{2}$  miles south of Cape George.

A contract entered into in 1872 for the construction of a breakwater to extend 400 feet from a point on the north side of the cove, was completed the following year. The work was 20 feet in width over a distance of 200 feet from the shore end, 30 feet over a further distance of 160 feet and 40 over the remaining 40 feet. The depth at the outer end at extreme low water was about 16 feet. Spring tides rise 4 feet. Repairs were made from time to time till 1879 when the work was carried away to within 100 feet of the shore end down to from 6 to 3 feet below low water. During the summer of 1883, 70 feet of the work was rebuilt, and during the winter of 1883-84 it was extended 94 feet. In April, 1884, the 94 feet extension was badly damaged by drift ice and subsequently carried away.

A contract entered into in 1887 for the reconstruction of 160 feet of the work, was completed in 1888. The new work is 32 feet in width on top and 42 feet at the bottom and has a sloping face from one foot above low water on the north side and the outer end. It is strongly constructed and founded on a bottom prepared by removing the remains of the former structure down to 12 feet below low water at the outer end, and to 6 feet at the inner end. At the outer end there is now from 9 to 12 feet at extreme low water, and from 7 to 9 feet over a distance of 100 feet out. Access to its sheltered side is obstructed by a deposit of ballast and gravel, over which there is a depth of from 5 to 4 feet at the outer to 2 feet at the inner end.

During the year 1890-91 the amount authorized was expended in renewing the covering, floor stringers and cap timbers of the work over a distance of about 100 feet from the inner end, and in procuring 125 pieces of piling.

#### Ogilvie's Pier.

Ogilvie's Pier is situated on the southern shore of the Bay of Fundy, about 3 miles west of Harbourville and 52 miles east of Digby Gut.

The inshore end of the work is old and much worm-eaten and a hole had been made by the sea into the interior of the work. The gravel was removed to a depth of 3 feet, new timbers were inserted where practicable and the interior of the cribwork filled with brush and large stone ballast.

#### Parrsboro' Pier.

Partridge Island or Parrsboro' Pier, Cumberland County, is situated on the north side of the Basin of Minas, about a mile to the westward of the mouth of the Partridge Island River and about 2 miles distant from the town of Parrsboro', the terminus of the Cumberland Railway and Coal Company's Railway.

The pier which is 500 feet in length, being directly on the seashore, has the benefit of the full extent of the tides, and as vessels can approach it and leave it at half-tide, it is the principal point of communication between Cumberland County and the counties of King's and Hants, on the south shore of the basin, and the steamers of the Basin of Minas, and St. John and Basin of Minas routes call there regularly during the season.

During a heavy south-easterly gale on 1st of October, 1889, the top of the outer end of the pier for a distance of 30 feet, and 4 feet in depth, was wrecked, the face timbers having been knocked out of their places, the ballast washed out, and a portion of the top flooring removed.

During last spring a small sum was expended in placing and securing some long piles on the inner face of the outer end, to fender off the steamers which during high water springs were in danger of going on the wrecked portion of the pier.

Spring tides rise 41 feet, neap tides rise 34 feet.

#### Pictou.

Pictou Harbour is pronounced by Admiral Bayfield to be in every respect the finest on the southern shore of the gulf eastward of Gaspé. It is situated at the head of a bay which is  $1\frac{1}{2}$  miles wide and  $1\frac{1}{2}$  miles deep. The mouth of the harbour is over one-quarter of a mile wide, and there is a depth of from 30 to 40 feet in the channel as far as the town, which stands on the north side 2 miles distant from the lighthouse. The flats, however, extend some distance beyond the ends of the wharves. On the south side is the terminus of the Pictou branch of the Inter-colonial Railway, the principal point of connection between Nova Scotia and Prince Edward Island.

Opposite the town the harbour divides into three large arms called the East, Middle and West Rivers. The last two may be navigated without much difficulty for two or three miles above their confluence, but higher up they become divided into several small channels obstructed by oyster beds.

During the year the dredges "St. Lawrence" and "Canada" did some work on the channel leading to the market wharf, while the latter did three days' work deep-

ening along Dwyer's wharf. Full details of this work are given under the various dredges at the end of this report.

#### PORT GEORGE.

Port George, Annapolis County, is 37 miles east of Digby Gut on the south shore of the Bay of Fundy.

The harbour is dry at low water and is formed by a western breakwater and an eastern pier, both of which works were built by the local authorities.

In 1875, the Department expended the sum of \$7,000 in repairing and refacing the breakwater, which was much decayed and worm-eaten.

In the autumn of 1883, the outer end of the breakwater was destroyed by a severe storm, the outside 165 feet being swept away, and the adjoining 30 feet being much shattered and injured.

During the spring of 1890 a contract was entered into for rebuilding the destroyed section, and subsequently a second contract was made for removing and rebuilding the 30 feet or damaged section.

During the past fiscal year these contracts have been completed. The work is built of round timber, and all the cribs filled solidly with stone ballast; the seaward face has a double set of face timbers, and is sheathed outside of them with 7 inch sheathing. The work is 33 feet wide on top, and there is a break of square timber 7 feet high and heavily kneed, extending the entire length of the seaward side.

#### PORT HOOD.

Port Hood, the shire town of the County of Inverness, is on the west coast of Cape Breton Island, 20 miles north of the northern entrance to the Strait of Canso.

The harbour was formerly a secure and natural one; Smith's Island, which is two miles in length, and forms its western side, having been connected with the main land by a range of sand hills. In 1839, the sea made a breach in this protection; the opening, at first narrow, was enlarged by the tidal currents with increasing rapidity, until it was swept entirely away and its site covered by 15 feet of water. The harbour is now unsafe during north-easterly gales, except in a small cove on the east side of Smith's Island.

A pier 550 feet long and 24 feet wide, with an L 100 feet by 25 feet, was built on the eastern shore of the harbour in 1865-66 by the Provincial Government. When first taken in charge of by the Department it was in need of repair. Owing to its exposed position the pier has been frequently damaged by ice and storms and the damage done made good.

During this fiscal year the amount authorized was expended during the autumn of 1890 in cutting down, rebuilding and close-piling the outer face of the 71 foot block, and in slight repairs to the covering and to the stone slope on the north side. The following spring the work was considerably damaged by ice. Repairs were effected by reconstructing from low water, and close-piling 80 feet of the north face; reconstructing the upper portion of the work, including the renewal of the covering, floor stringers, upper cross ties and about 2 feet of ballast from the inner to the outer end; reconstructing 40 feet of the south face near the inner end, and in replacing some pieces of covering and cap timbers of the L.

The depth at extreme low water at the outer face of the 71 foot block, varies from 15 at the north to 9 feet at the south end. Spring tides rise 4 feet.

#### PORT MAITLAND.

Port Maitland, formerly called Green Cove, Yarmouth County, is about 13 miles north of the town of Yarmouth.

The harbour, which is dry at low water, is formed by a western breakwater and an eastern loading pier. It is an important fishing station, and besides the number of small boats and vessels employed, considerable capital is invested in the fitting out and management of "traps" or deep water weirs.

In the winter of 1887-88 the breakwater was seriously damaged by a succession of westerly storms and a breach of 86 feet in length was made directly through the work.

On the 24th June, 1890, a contract was made for rebuilding the destroyed section and repairing the other parts of the work.

The wreckage of the old work was removed down to its foundation and the breach filled in and rebuilt entirely with new timber. The balance of the seaward face—that is to say 83 feet in length outside the new work, and 100 feet between it and the shore—was close-piled, the entire top (including the cap, covering floor stringers, the first set of cross ties and the “break” of these two sections was rebuilt, and new fenders were fitted to the inside face.

#### PORT LA TOUR CANAL.

Port LaTour Canal, Shelburne County, commonly called the “Haulover,” is a cutting or boat canal about 1,250 feet long, 12 feet wide and 6 feet deep, across the isthmus which separates Port LaTour from Negro Harbour.

This cutting was made many years ago by the local authorities to enable fishermen and others to pass from one harbour to the other, effecting a saving in distance of from 7 to 10 miles and avoiding the dangerous passage around Blanche Point and its neighbouring shoals and ledges. The isthmus is low and flat, and the beaches at both ends are hard and stony, but the middle is a soft marsh.

The work having been poorly constructed in the beginning, and no repairs having been made for some years, the whole work fell into a dilapidated condition and became almost impassable for boats even at high water.

At the last session of Parliament an appropriation was made for repairing the work and during the past fiscal year the canal has practically been rebuilt. It has been widened, deepened, and the walls on both sides for the entire length of the work rebuilt. The canal is now 12 feet 6 inches wide in the clear at the bottom, and 14 feet 6 inches on top and at ordinary spring tides there is 4 feet 6 inches of water for the total length of the canal, and it is available for the passage of fishing boats from 2 hours flood to 4 hours ebb, or 8 hours out of each 12.

At the Port LaTour or western end cribwork guide piers have been built 75 feet long, 10 feet wide, and 6 feet 6 inches high, these are built of round timber with a substantial ballast floor over the lower tier of timber and fitted to the top with ballast. The Negro Harbour or eastern piers are constructed in a like manner and are 87 feet long. The centre portion of the canal which is through the marsh has its walls constructed of ballasted cribwork and the ends which are through harder material have stone walls. The ebb and flow of tide makes a strong current through the canal and scours the bottom clear of mud and silt.

#### SOUTH GUT.

South Gut, Victoria County, is the local name of the south arm at the head of St. Ann's Harbour. The latter is a fine basin, 7 miles in length, the entrance to which is a few miles to the westward of the principal entrance to the Great Bras d'Or Lake.

During the year 1890-91, the construction of a wharf extending 198 feet, to 6 feet at extreme low, or 12 feet at extreme high water, was commenced. It consists of a shore abutment 48 feet long and 20 feet wide, and of 3 central blocks each 20 feet by 20 feet, and an outer block 20 feet by 40 feet with openings of 17 feet 6 inches.

At the close of the fiscal year when operations were suspended, the work was within 3 or 4 feet of required height, and all the material required to complete it had been procured.

#### SOUTH INGONISH.

The harbour of South Ingonish, Victoria County, is on the east coast of Cape Breton Island, midway between Sydney Harbour and Cape North.

On the completion in 1876 of works undertaken to improve the entrance to the harbour, there was left a channel 200 feet in width with a depth at extreme low

water is not less than 12 feet, and with a protection work on the north side 350 feet in length. The protection work has since been destroyed and the channel has narrowed and shoaled to some extent, but it is still somewhere over 100 feet in width, and has a length of not less than 100 feet, since at extreme low water. Spring tides rise 3 feet.

With the amount appropriated for the fiscal year 1900-1901, materials to be used in the construction of a wharf 25 feet in length and 10 feet in width has been provided, but pending the selection of a suitable location, work of construction was not commenced.

#### STONY ISLAND.

Stony Island is a desolate fishing station on the east side of Cape Sabine Island, the latter being about midway between Cape Sabine and North-East Point.

At the last session of Parliament an appropriation was made for the construction of a breakwater for the protection of fishing boats, and in the autumn of 1900 a contract was entered into for the construction of the work.

As there is no timber on Cape Sabine Island the materials were obtained on the mainland, during the winter months the men building operations were begun in the spring as soon as the timber could be floated to the site.

The proposed breakwater when completed will be 100 feet long and 12 feet wide at the base, and will extend a distance of 125 feet. The outer section will be constructed of criework and the remaining or inner portion of pile walls. The latter section will be protected on the seaward side by a row of stone-piling, their tops being set 4 feet above the level of the water at high tide, to prevent the sea from running over and the criework section will have a concrete or masonry timber of a similar height.

#### SIMMERVILLE WHARF.

Simmerville, Hanover County, is situated on the eastern side of the Aron River, about midway between the town of Windsor, the seat of the county, and the mouth of the river where it empties into the Basin of Minas.

The wharf was constructed many years ago by the inhabitants, aided by the local government, and with the best of care and some trifling repairs, no work had been done since 1870. At that time the structure had been abandoned as useless for the wants of the place, and Messrs. Chisholm and Hantsworth, intending to place a steam tug on the route between Simmerville, Hanover and Windsor, repaired the wharf and now extend it a distance of 100 feet at their own expense.

During the past season the Department commenced the reconstruction of the wharf. The work was at first done by the local men, by removing the old top to a depth of about 10 feet and by rebuilding it to a length of from 50 to 75 feet, and by placing concrete in the new 5 feet draft, and during the past year the repairs commenced at the other end, and a new section of the wharf shown in the accompanying plan.

The total length of the wharf is 100 feet, varying in width from 25 to 31 feet, and a depth from 5 to 15 feet, the latter being the depth at the outer end.

#### TATAMAGOUCHE.

The Tatamagouche River empties into the Bay of Fundy, into the south-west corner of Tatamagouche Bay, about 5 miles from the mouth of the river.

Between the 20th and 21st September 1890 the schooner "McKenzie" was damaged by running aground, and the cargo of 1,755 bags of mud and manure being ruined.

#### TRACADIE.

St. Lawrence Harbour, Antigonish County, is situated on the southern shore of the George Bay, about 4 miles from St. Lawrence Island station.

It is an extensive sheet of water having a length of from 10 to 14 feet over a large part of its area, the entrance channel however is narrow and crooked.

By the 24th July, 1890, the dredge "Geo. McKenzie" completed a channel 750 feet in length, 200 feet wide at the river end and 170 feet at the outer, with a depth of 7 feet at low water springs.

#### TIDNISH.

The Tidnish River enters Bay Verte on the southern side and near its head. It is the largest stream entering the bay, and for a short distance from the mouth it forms the boundary line between the Counties of Westmoreland, in New Brunswick, and Cumberland, in Nova Scotia, the western shore being in the former and the eastern in the latter province.

Tidnish Head, about  $1\frac{1}{2}$  miles to the eastward of the mouth of the river, is the eastern terminus of the Chignecto Marine Railway, now under construction.

On the 4th day of July, 1890, a contract was entered into for the construction of a public wharf on the south-eastern side of, and near the mouth of the river in Cumberland County, and it was satisfactorily completed on the 13th May.

The wharf is 220 feet in length and 20 feet wide, with an L on the upper side of its outer end, sloping 1 in 8 on the inside, and 1 in 2 on the outside, for the purpose of forming a harbour inside. It is built of round timber, thoroughly ballasted and covered with plank, and its sides and end are well protected by fenders and fender piles.

#### VICTORIA.

Victoria pier is situated on the Bay of Fundy shore of King's County, and is distant about 2 miles east of Morden, and about midway between this latter and Ogilvie's pier.

During the past fiscal year some repairs were made to the covering, a portion of the structure was ballasted and two additional mooring posts placed in convenient positions.

#### WALTON.

Walton Harbour, Hants County, is the outlet of the LaTete River, and is situated on the southern shore of the Basin of Minas, Bay of Fundy, about 14 miles to the westward of Noel Bay, and 14 miles to the north-eastward of Cheverie at the mouth of the Avon River.

A contract was entered into in December, 1890, for the construction of a break-water on the eastern side of, and near the mouth of the harbour, 250 feet long and 20 feet wide, sloping 1 in 8 on the inside, and 1 in 2 on the outside, for the purpose of forming a harbour inside.

The work has been carried on in a very vigorous manner, and at the end of the fiscal year the bottom of the outer end for a distance of 130 feet inward had been built up to an average height of 6 feet and thoroughly ballasted.

#### WEYMOUTH.

Weymouth, Digby County, is situated at the entrance of the Sissiboo River, which empties into St. Mary's Bay, and is distant 20 miles from Digby.

The "St. Lawrence," having been ordered for work in the River Sissiboo at Weymouth, left Pointe du Chêne on 25th October. The passage was long and stormy and the season late, and when Weymouth was reached and the dredge got to work it was found impracticable to continue owing to the hard nature of the bottom.

#### WRECK COVE.

Wreck Cove, Victoria County, is on that part of the east or Atlantic coast of Cape Breton Island known as the "North Shore," between the Harbours of St. Ann's and South Ingonish, and distant from the former 18 and from the latter 12 miles.

A former landing place for boats, near the mouth of Wreck Cove Brook, was rendered unsafe by a divergence of the stream and the opening of a second outlet.

During the year 1890-91 the amount appropriated, together with \$200 paid by the locality, was expended in the construction of a dam of brush and stone 675 feet

in length, 16 feet in average width, and 6 feet in average height, designed to confine the stream to its former channel and thus restore the landing place to its original condition.

## NEW BRUNSWICK.

### ANDERSON'S BOLLW.

Anderson's Bollw, Albert County, is situated on the northern shore of the Chignecto Channel or north-eastern arm of the Bay of Fundy and on the eastern side of Salisbury Bay lying between Cape Enrage and Matthew's Head.

The formation of a harbour was first commenced by the Department in 1879-80, an isolated block 100 feet in length and 25 feet in width being constructed at a distance of 500 feet from the shore and some 200 feet from extreme low water mark, additions being made in 1883-84-85-86, and 1887-88, of 40, 100 and 260 feet respectively, forming a connection with the shore, to which also the Local Government in 1886 built a public road and approach, the Marine Department also erecting and maintaining a light on its outer end.

During the fiscal year repairs were made to a portion of "breaks" damaged by a severe storm that occurred in early part of November, 1900.

### CAPE FORMENTINE.

Cape Formentine is on the New Brunswick coast of Northumberland Strait and is the nearest point to Prince Edward Island, from which it is distant about 9 miles.

At the point of the Cape an artificial harbour is in course of construction. The work consists of a straight pier 2,500 feet in length with a head and return, each 400 feet in length, enclosing a basin a little over 4 acres in extent, having an extreme depth of 15 feet at low water or 22 feet sometimes at high water-spring tides.

For a distance of 1,200 feet from the shore, the pier is composed of stone embankment 20 feet wide on top with slopes of 2 to 1. The remaining 1,200 feet is enclosed cribwork 20 feet wide. The head and return will be of similar cribwork, but the width from the bottom up to low water will be 40 feet, decreasing to 30 feet at the finished level of the work and presenting a sloping face sheathed with hard-wood to the south and east.

During the fiscal year the substructure of the cribwork of the pier has been extended 700 feet to a point 2,400 feet from high water mark, while a length of 860 feet of superstructure has been nearly completed, a stone slope has also been carried out 500 feet in length in the north side and 300 feet on the south side of the work, while the slopes of the stone embankment were brought around crib No. 1.

At the close of the fiscal year the work was still in progress.

### CARQUEST.

Bridgetown, Gloucester County, is the name of the railway station situated at the upper or western end of Caraquet Harbour and Settlement, and is 2 miles east of the bridge crossing the Caraquet River and 6 miles west of existing public wharf near Caraquet Station.

Directions of Bridgetown extensive oyster beds are situated, causing this portion of Caraquet Harbour to be known as the "Oyster Grounds."

To provide shelter and a landing place for boats, a contract was entered into 25th October, 1900, for the construction of a work to be 450 feet long, consisting of a shore approach 100 feet long four blocks each 15 by 15 feet, 5 spans or openings of 20 feet each, and an inner pier 10 by 30 feet. The shore approach and the several blocks to be constructed of round logs open cribwork, the spaces or spans between being each spanned with four 10 by 12 stringers, the blocks and approach to be reinforced in the sides and butt braced, the whole being covered with plank decking.

The timber required having been got out during the winter, construction was commenced about the 1st June, and by the end of the fiscal year the work was well under way and the blocks as well as the approach being commenced and built up to about one-third of height required.

## CAMPBELLTON.

Campbellton, Restigouche County, is situated on the southern side of the Restigouche River, about 15 miles west of Dalhousie, the shire town and where the river enters the Baie des Chaleurs; it is an important station on the line of the Intercolonial, as well as a thriving and growing town, latterly doing an extensive business in the shipment of lumber.

Campbellton is practically at the head of navigation although the tide flows up the river some 9 miles further, but shoals and the intricacy of the channel prevents the passage of vessels of any size, except on the "Traverse" about 4 miles below Campbellton where the depth is only about  $12\frac{1}{2}$  feet, a depth of 18 feet at low water springs can be carried up to the town, which, with the rise of  $10\frac{1}{2}$  feet at springs and 7 feet at neaps, affords a good depth of water for the class of vessels engaged in trading to and from the port, these being generally barques of from 400 to 900 tons. The greater number of these arrive in ballast, the disposal of which has been a matter of serious inconvenience, owing to there being no convenient place of deposit. To remedy this a contract was entered into on the 23rd April, 1889, for the construction of a "ballast wharf," the structure being an isolated block, 140 feet in length by 35 feet in width on top and having a minimum depth of 18 feet at low water spring tides; this work which had been in progress during the previous year, was completed on the 30th of August, 1890.

The work done during the fiscal year consisted in putting on covering, constructing ballast traps and ladders, some little ballasting and further bolting of fenders.

To complete the landing and approach required for the accommodation of the ferry steamer plying between Campbellton and Cross Point (directly opposite), on the Quebec shore of river, a contract was entered into 31st March, 1891, for the construction of the work to extend 250 feet in length from the outer end of the work built by the Department by day's labour in 1889-90 at site selected and provided by the Campbellton Town Council. The work contracted for consists of four cribwork blocks, respectively 50, 20, 20 and 100 feet long and three spans or openings of 20 feet each, the latter spanned by four 10 by 12 inch stringers, the work being covered with 4 inch planking. The first three blocks and all the spans are to be 20 feet in width from outside to outside of cap timber, the fourth or outer block for a distance of 40 feet, to be 30 feet wide, while its remaining length or that portion of it forming the incline will be 20 feet in width.

At the close of the fiscal year, most of the materials required had been provided, and construction would shortly commence.

## EDGETT'S LANDING.

Edgett's Landing, Albert County, is situated on the west side of the Petitcodiac River, about 10 miles from its mouth, and two miles south of the Village of Hillsboro', a railway and telegraph station, and also business centre of the county.

To facilitate the discharge of ballast from vessels, a contract was entered into, 15th of January, 1889, for the construction of a "ballast wharf" at Edgett's Landing, on the site where many years ago the Government of New Brunswick had constructed what was known as the "Steamboat Wharf." The wharf contracted for is 400 feet in length, and reaching to about 150 feet of low water mark, having at its outer end 30 feet of water at high water spring tides which rise 45 feet, neaps 38 feet.

Owing to the failure of the contractors to prosecute the work, in September, 1889, the contract was cancelled by Order in Council, and materials that had been supplied taken charge of by the Department, the construction of the work being resumed under direct charge on the 20th May, 1890, and continued until end of November, at which date the outer 100 feet was built up to the proposed height, and partly fendered; the next section, 100 feet long by 30 feet wide, composed of round logs, open cribwork, to within 4 feet of required height, while of the remaining

length of proposed cribwork, 150 feet long and 20 feet wide, one-half has been built up to within 4 feet of the top.

#### GRAY'S ISLAND.

Gray's Island, Albert County, is situated on the west side of the Petitcodiac River, two miles north of the village of Hillsboro'.

A contract was entered into 27th October, 1890, for the construction of a breakwater, for the protection of shipping, 300 feet long over all, to extend from the shore a short distance above the site of the wharves. The first 100 feet or inner end of the work is merely "clay-diving," 5 feet wide on top sloping 1 to 1 on the sides. The next 100 feet outwards is of round logs, open cribwork, 15 feet wide on top, and sloping 1 in 4 on the sides; the next 50 feet to have its upper 30 feet similar to last described, excepting that the northern or upper side shall have the face longitudinal of square timber, and face close sheathed with spruce spars, flatted to 6 inches in thickness, the bottom being built plumb, and its northern or upper side protected by close-piling. The outer 50 feet is 25 feet wide on top, and for its upper 30 feet has a slope of 1 in 12 on the end, 1 in 4 on north side, and 1 in 2 on the southern or lower side, the bottom being built plumb, and having both sides and end protected by close-piling, and the upper portion of the work by close-sheathing of spruce and hardwood. Materials having been procured during the winter, delivery of timber was commenced on the opening of navigation, and construction began about the latter part of May, and at the close of the fiscal year good progress had been made.

#### KINGSTON.

Kingston, Kent County, is situated on the Richibucto River, 3 miles south of Richibucto, the shire town, and 6 miles from the mouth of the river which enters the Straits of Northumberland.

The river above Kingston being poorly provided with shipping facilities, a contract was entered into in May, 1890, for the construction of a wharf on the upper side of the Kingston bridge, to provide additional accommodation and a means of warping vessels through the "draw." The proposed work is to be 200 feet long and 35 feet wide on top, the ends and outer or north face being built close faced of square timber, and the inner or south side open faced, both sides and ends to have a slope of 1 in 12. It will be connected with the public road bridge by an approach 63 feet long measured along its centre, and 20 feet wide, to be built of round logs, open cribwork, daisiated, with floor stringers and planked over.

Materials for the wharf were procured during the winter and construction commenced early in the spring, but the work has been much delayed owing to a stranded schooner at the inner end of the site of the work. At the close of the fiscal year the outer 100 feet was two-thirds completed and the building of the approach commenced.

#### NEGRO POINT BREAKWATER.

St. John Harbour, on the north side of the Bay of Fundy, is the estuary of the River St. John, and lies at the head of a small bay, the distance between "Red Head" and "Negro Town Point" at the eastern and western sides of the mouth being about  $2\frac{1}{2}$  miles. Partridge Island, which lies a little more than a half mile outside of the line of points named, divides the entrance of the harbour into two channels. During south-easterly winds the sea is broken by Inner Mispec Point (which bears south by west two miles from Red Head), and by the shoal water between Red Head and the main or eastern channel. South-westerly winds throw in a heavy sea through the western channel, which rendered it difficult for vessels to enter the harbour, as they were in danger of being driven on to the "Ford Sound," on the eastern side of the main channel.

During 1874-75 a thorough survey of the harbour was made by the engineers of the Department, and in the spring of 1875 a breakwater 2,250 feet long, to partially close the western channel, was begun, and in September, 1877, completed.

Injury having been done to portions of the slopes, top and outer end of the work by storms, a contract was entered into 19th January, 1891, for supplying a quantity of stone for its repair, delivery of which was in progress; by end of fiscal year, about 1,000 cubic yards having been delivered and placed at the most exposed parts of the work.

#### OROMOCTO SHOALS.

The obstructions known as the "Oromocto Shoals" are situated on the St. John River, about 10 miles below Fredericton, and at low stages of the water in the river have always proved serious to navigation. At this point the river widens, separating into three channels divided by Oromocto and Thatch Islands, the navigable channel being the central one between the islands, although not so wide as that on the eastern side of Oromocto Island, while the one west of Thatch Island is but small. This latter in 1877-78-79-80-81 was closed by a "Shear Dam" 2,200 feet in length, extending from the "Lincoln Shore" to the head of the islands in order to increase the current and prevent sediment being deposited on the "Shoals."

Owing to natural decay of the wood, and injury received from drift logs, ice, &c., many portions of the covering of the top and slope had been damaged as well as other portions of the work, and during the past fiscal year, a length of 627 feet of the slopes and 780 feet in length of the top have been replanked, and general repairs effected.

#### POINTE DU CHÊNE (SHEDIAC).

Pointe du Chêne is on the south-east side of the entrance to Shediac Harbour, and is the eastern terminus of the New Brunswick division of the Intercolonial Railway.

The dredge "St. Lawrence" operated in the harbour of Pointe du Chêne from 27th July to 24th October, 1890, giving a depth of 16 feet at low tide from outside the "spit" to the wharf, as well as making a basin 500 feet long by 150 feet wide at the western front of the railway wharf.

#### RICHIBUCTO.

Richibucto Harbour, Kent County, is situated on the south-west shore of the Gulf of St. Lawrence, about 40 miles north from Pointe du Chêne (Shediac Harbour) the eastern terminus of the Intercolonial Railway.

The work done during the present fiscal year consisted in putting on additional walings to a length of some 300 feet of beach protection, and filling in ballast where settlement had taken place, and in filling with brush and ballast two portions of the breakwater proper, and extending the beach protection a distance of 140 feet.

The "St. Lawrence" arrived at this place on the 12th June, 1891, and at the close of the fiscal year was engaged in improving the Albion or Middle Channel.

#### RIVER KENNEBECASIS.

River Kennebecasis takes its rise near the sources of the Petitcodiac and after a south-west course of about 20 miles enters the St. John through Kennebecasis Bay.

At the commencement of the fiscal year the "New Dominion" was engaged in deepening and straightening the channel at Perry's Point till the 13th September, when work was begun at Lamb's Point above the bridge, where the dredge remained until 11th November.

On the 16th May, 1891, work was begun at Hampton in deepening the channel to 8 feet; but the water falling too low for the dredge to work it was again taken to Lamb's Point where it was operating at the close of the fiscal year.

#### RIVER ST. JOHN.

The St. John is the largest river in the Maritime Provinces, having a length of about 500 miles; it takes its rise in the State of Maine near the source of the Penobscot

and Connecticut Rivers, and falls into the Bay of Fundy at the harbour and city of St. John. Its length in New Brunswick may be divided into three sections: the first, 75 miles in length, between the mouth of the St. Francis (where the river first touches Canadian territory) and the "Grand Falls" (to within 2 miles of which latter point it forms the boundary line between Maine and New Brunswick.) The second, 140 miles in length, between "Grand Falls" and Fredericton, and the third, 80 miles in length, between Fredericton and St. John. The first section is navigated only by tow boats, though at one time a small steamer plied on it occasionally. The second is navigable by steamers of light draft during high water in spring and fall, and generally by tow boats during open water, the rapidity of the current preventing the employment of sailing vessels beyond "Spring Hill," 6 miles above Fredericton. The third section (over all of which the influence of the tide is slightly felt) is navigable for steamers and sailing vessels drawing not more than 10 feet.

During the fiscal year, for the improvement of the navigation of the river on the portions above Fredericton, the following work was performed: At the "Grand Pass" at foot of (Sugar Island) 7 miles above Fredericton and "Bear Island Bar" 25 miles above, the channel was deepened by use of scrapers, and boulders were removed.

At "Meductic Falls," "Belvisor's Bar" and "Howe's Point," 40 to 50 miles above Fredericton, the channel was deepened by the use of scrapers, and dangerous rocky ledges were blasted, in addition to which a number of large boulders were removed from the channel. At Grand Falls, a small amount was expended in repairing the breakwater or shear dam built many years ago.

The tow paths between Grand Falls and the St. John, boulders, rocky ledges, &c., were removed.

#### SHIPPEGAN.

Shippegan Harbour, Gloucester County, is situated near the entrance of the Baie des Chaleurs, about 60 miles east of Bathurst.

At the southern end of Shippegan Harbour connection is made with the Gulf of St. Lawrence by "Shippegan Gully," a shoal and difficult channel formerly used during fine weather by the smaller fishing boats and vessels of very light draft.

By the use of the "gully" a saving in distance is made of from 25 to 40 miles for the fishermen going or returning to their homes from the fishing grounds situated off this part of the shore, while the harbour is also a most desirable shelter during storms, being perfectly protected from all winds and largely used by all of the fishing vessels of the extensive fishing establishments of Caraquet and other parts of the south shore of the bay.

To make the "gully" available for vessels of a larger class and permit of it being entered at all time of tide or during stormy weather, the Department in 1875 commenced the construction of a breakwater to protect the entrance, and a "dam" to close an opening known as the "east gully." Difficulty was had with the contractors, who suspended operations at the close of the summer of 1876, and the work was re-let in December, 1877, operations being resumed April, 1878, but the second contractors, about the end of July, stated their inability to proceed further with the work, and it was taken over by the Department.

At this time the "dam" was completed, about 900 feet of the breakwater was raised to its proper height and a further length of 500 feet partly built.

In October, 1879, a storm occurred during which the tide rose much higher than before known, seriously injured the "dam," while the unfinished outer 500 feet of the breakwater was completely destroyed and the inner portion much damaged. In 1880-81 the dam was repaired, raised and strengthened by piles driven 10 feet apart, connected by caps and walings. During 1883 portions of it that had again settled were raised where deemed unsafe, and an extension of 120 feet added to the remains of the breakwater, a gap that had been made being closed as well, and other portions of the structure raised.

General repairs were again made in 1884-85, when 50 feet of the outer end was close-piled, the "dam" at the time being raised where settlement had taken place. Further close-piling and some general repairs of the work were also done in 1886-87, while during 1888-89 a length of 60 feet which had been seriously damaged the previous winter was reconstructed.

In November, 1889, a contract was entered into for an additional block of 50 ft. at the end of the eastern or existing breakwater, and the construction of a breakwater to extend 1,100 feet in a southerly direction from the beach west of the "gully."

Materials for the works were got out during the winter of 1890 and work commenced in the spring of that year, since which it has been actively carried on so that at the close of the fiscal year, 30th June, 1891, it was well advanced towards completion.

#### TYNEMOUTH CREEK.

Tynemouth Creek, St. John County, empties into the northern side of the Bay of Fundy, about 25 miles to the eastward of the harbour and city of St. John.

At its mouth the creek is contracted by a sea wall of coarse gravel extending from the western side, enclosing extensive flats having over them a good depth of water (10 to 15 feet) at high water springs, thus forming an excellent harbour for small vessels.

In 1874-75 the Department constructed a small breakwater on the eastern side of the entrance to protect vessels from danger of striking on the rocky ledges that formed the eastern side of the entrance, a similar work being built in 1882-83 on the western side to prevent the wearing away of the end of the sea wall.

During the past fiscal year the western breakwater was repaired and extended, and some dangerous rocky ledges were removed from the channel.

#### QUEBEC.

##### ANSE ST. JEAN.

Anse St. Jean is situated on the south-west bank of the Saguenay River, about 25 miles from its mouth.

That portion of the wharf which settled in the spring of 1889 was raised from  $2\frac{1}{2}$  to 3 feet over a length of 135 feet, and the flooring was renewed with 6 x 6 in. tamarack.

A quantity of stone was placed in the eastern portion of the wharf, and the freight shed repaired.

##### BAIE ST. PAUL.

Baie St. Paul, County of Charlevoix, is situated on the north shore of the St. Lawrence, 60 miles below Quebec.

During the past fiscal year the extension of 75 feet to the wharf at this place was completed, and there is now a depth of 9 feet at low water spring tides at its outer end.

The wharf is now 861 feet long with a width of 30 feet.

Spring tides rise 24 feet, neaps 13.

##### BEAUHARNOIS.

The "Nipissing" operated at this place between 16th July and 25th August, 1890, digging up old piers and cribwork and deepening the channel in front of the village wharves to a depth of 10 feet; 12,060 cubic yards of clay, stone and boulders being removed.

##### BELCIEL.

Belciél piers and booms are on the Richelieu River, south of the Grand Trunk Bridge, which crosses the river at Belciél; they were built to facilitate the passage

of floating logs driven through the spring race to prevent them from being carried to the fall & winter.

There are two floating docks, one of which was set up from water line last year.

#### BEAVERHEAD

Beaverhead is the name given to the south shore of the St. Lawrence, 15 miles east of Lake Umbagog.

The winter wharves, during last year, consisted in the construction of a new dock, 100 feet in length, the use of which is the subject of item 1.

#### BEAVERHEAD

Beaverhead is the name given to the south shore of the St. Lawrence, 15 miles east of Lake Umbagog.

The dock, 100 feet in length, was built some years ago near the mouth of the Beaverhead, and was used for the winter.

During the winter of 1910, the dock was extended and brought to the level of the water, and the approach to the wharf raised.

The dock is now 100 feet long and 10 feet wide.

#### BOUCHERVILLE

Boucherville is the name of the village situated on the south shore of the River St. Lawrence, 15 miles east of Lake Umbagog.

During the winter of 1909, the Boucherville Navigation Company built a dock 100 feet in length by 25 feet in width, with a breakwater 10 feet in width at the outer end, at a distance of 175 feet from the shore. The Boucherville Navigation Company owned the dock over to the Municipality of Boucherville in the summer of 1910. This dock is situated at the upper end of the village.

During the winter of 1910, the dock was extended and brought to the level of the water, and the approach to the wharf raised. The dock is now 100 feet long and 25 feet in width, with a breakwater 10 feet wide at the outer end.

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**CHICOUTIMI.**

Chicoutimi is at the head of navigation on the River Saguenay, 71½ miles above Tadoussac.

During the year the retaining wall of cribwork 14 feet in width which is being built along the slab wharf, was extended a further length of 130 feet; a waiting room 28 x 20 feet built at the southern end of the wharf, and the plank of the wharf was repaired at various places.

**COTEAU LANDING.**

Coteau Landing is situated on the north side of the River St. Lawrence, at the foot of Lake St. Francis. It is the chef-lieu of the County of Soulanges, two miles from Coteau Station, Grand Trunk Railway, and 36 miles west of Montreal. It is also a station on the Canada Atlantic Railway.

During the season of navigation, the Richelieu and Ontario Navigation Company's steamers call at Coteau Landing, besides several local lines of boats. It is the chief grain shipping port of the county.

There are several wharves at Coteau Landing, but the wharf known as the Richelieu and Ontario Navigation Company's is the one referred to in this report.

It is 904 feet in length including a block 279 feet by 24 feet at the outer end.

The bridge or approach has a general width of 12 feet, with two sidings for the crossing of teams.

Last fall the reconstruction of the outside block 279 feet by 24 feet was commenced, but was not completed at the close of the fiscal year.

**ETANG DU NORD.**

Etang du Nord is at the western end of Grindstone Island, one of the Magdalen Islands in the Gulf of St. Lawrence.

The breakwater at this place, which had received damage from storms, was repaired where required, and heavy stones placed in the talus to fill gaps which had been made.

**GATINEAU RIVER, EAST BANK.**

In November last, a grant was made for the building of a retaining wall on the east bank of the river, about one mile above the Gatineau Point church, to stop any further encroachment of the river bank, along which runs the public highway.

This retaining wall is 340 feet in length and is built of pile work. The space between the front row of piles and the bank is filled with fascines and stone.

**GRANDE RIVIÈRE.**

Grande Rivière, is in the County of Gaspé, and is situated on the Baie des Chaleurs.

At the close of the fiscal year the wharf under construction by contract at Robin's Point was well advanced towards completion.

This wharf when completed will have a total length of 457 feet, with a width varying from 25 feet 9 inches on top to 38 feet at its outer end, where there is a depth of water of 19 feet at low water springs.

On the northern side of the wharf there will be a slip and two stairways for the accommodation of those using the wharf at different stages of tide.

**GROSSE ÎLE QUARANTINE STATION.**

Grosse Île is an island on the St. Lawrence, 33 miles below Quebec, and is the place where steamers and vessels on their way to Quebec report any case of infectious diseases they may have on board.

The outer end of the wharf having become much damaged owing to natural decay, it was found necessary to repair the same to make it available for any vessel or steamer that might have to tie up to it. Accordingly extensive repairs and renewals were commenced, but had not been completed at the close of the fiscal year.

## ISLE VERTE.

Isle Verte, on the south shore of the St. Lawrence, is in the County of Temiscouata, 17 miles below River du Loup.

The work during the last fiscal year has consisted in the construction of a further length of 164 feet of continuous open cribwork, to form the roadway to the isolated block.

## KAMOURASKA.

Kamouraska is on the south shore of the St. Lawrence, in the County of Kamouraska, 90 miles below Quebec.

The work performed at Kamouraska during the last fiscal year consisted in demolishing part of the old wharf, on its easterly side, and in rebuilding it with an inclined slip, 76 feet in length and 17 feet wide.

A stone protection wall of about 60 feet in length, 5 feet wide, has also been commenced on the easterly side of the old wharf from the inclined slip shorewards.

## LACHINE.

At the commencement of the fiscal year the "Nipissing" was working at this place dredging a channel in front of local wharves, removing 2,385 cubic yards of material.

## LAKE MEGANTIC.

Lake Megantic is a fine sheet of water lying between the Counties of Beauce and Compton.

In October, 1890, the Agnes pier at the foot of the lake was sheathed at the outer end, the plank covering renewed and the shed repaired.

The pier at Lourdes which had been considerably damaged by the ice received the necessary repairs.

## LÉVIS DRY DOCK.

In October, 1890, the Department of Public Works assumed control of this dock, which had up to that time been under the management of the Quebec Harbour Commissioners.

During January, 1891, iron beams made of boiler plate were placed under the bearings of the shaft of the main pumps in order to strengthen the bearings and do away with vibration. The machinery was painted and generally overhauled.

During June the sluice valves in the caisson and culverts were taken out of their seats, cleaned of all rust and replaced.

The inside of the caisson is being cleaned, and two coats of cement wash will be applied.

Since the Department assumed control the following vessels have used the dock:

1. S.S. "Barcelona," 1,886 tons, docked Oct. 31, undocked Nov. 4
2. S.S. "Oregon," 3,672 do Nov. 7 do Nov. 12
3. S.S. "Barcelona," 1,886 do Nov. 13 do May 12
4. Whale back str. "Jos. L. Colby," 1,243 tons, docked June 22, undocked June 28
5. Whale back steel barge No. 110, 1,227 do June 29, do July 1

Of these vessels the two last only have been repaired permanently while in dock.

A quantity of gravel and stones were removed by one of the departmental dredges assisted by a stone lifter, from the shoal at the entrance to the dock.

## LONGUEUIL.

The town of Longueuil, the chef-lieu of the County of Chambly, is situated on the south side of the River St. Lawrence, nearly opposite the eastern end of the city of Montreal.

The Richelieu and Ontario Navigation Company own a wharf at the upper end of the town, but the long distance from the business or centre portion, besides the increasing trade of the locality, demanded more wharf accommodation, and in the spring of 1887, at the request of the town council, the Department commenced the construction of a pier.

Last session the connection of the outside block was made with the shore under contract with Mr. J. A. Chagnon. The work was completed in November, 1890.

The pier is 1,105 feet in length, including a block 40 by 90 feet, 90 feet of the pier is 30 feet in width, and the remaining 975 feet, 20 feet. Seven buttresses, 10 by 30 feet, were built on the lower side. At the block there are 7 feet of water at its lowest stage. The pier is 9 feet 6 inches above low water line.

Considerable damage having been done by the ice to the portion of the pier built in 1887, some repairs were made.

#### MILLE ILES (NORTH BRANCH OF OTTAWA RIVER.)

The Mille Iles referred to here are situated in the north branch of the Ottawa River, north of Ile Jesus, in the County of Laval.

The work performed consisted in deepening the rapids at the foot of Lake of Two Mountains, so as to increase the flow of water through that branch of the Ottawa. A large quantity of stone was removed by blasting.

#### NEW CARLISLE.

New Carlisle is the chef-lieu of the County of Bonaventure, and is situated on the Baie des Chaleurs.

A contract having been entered into for the extension of the existing wharf at this place the work was brought to a satisfactory completion.

#### NEWPORT RIVER.

One of the retaining piers was widened and repaired, in order to make it available as a landing for boats and small craft, and the right of way has been given from the high road to this pier; a certain amount of blasting was done at the cliff, to make it accessible.

#### NICOLET RIVER.

The town of Nicolet, distant 13 miles from Three Rivers and 28 from Sorel, is situated upon the eastern side of the river of that name, which takes its rise in Lake Nicolet, in the centre of Wolfe County, and after a course of 80 miles, flows through the parishes of L'Espérance, St. Paul of Chester, St. Christophe, St. Albert, St. Clothilde, St. Monique, and St. Jean Baptiste de Nicolet, emptying into the St. Lawrence on its southern shore at the foot of Lake St. Peter.

In order to protect schooners loading in the harbour from the force of the storms on Lake St. Peter, a jetty was commenced in 1881, additions being made each consecutive year. The work in 1890 was resumed on the 31st July, the water having been too high to admit of its being commenced before.

It was discontinued on the 20th September, and during this time 300 feet of pile work was built, making the jetty 3,567 feet in length. It is 13 feet 2 inches in width and is 4 feet above low water.

The channel way, dredged opposite that part of the jetty built, has maintained its depth, but further out, beyond the jetty, the channel dredged has shoaled, owing to the working in of sandy deposits.

The total dredging done during the fiscal year 1890-91 was 11,470 cubic yards of sand material, in a cut of about 750 feet in length and 40 feet wide.

#### POINTE ST. PIERRE,

Gaspé County, is situated at the western entrance of Gaspé Bay, and is 21 miles distant from Gaspé Basin, and 15 miles from Percé.

A large amount of solid rock as well as dangerous boulders were, during the fiscal year, removed from the harbour.

#### POINTE À VALOIS.

Pointe à Valois is situated on the south shore of Lake of Two Mountains, in the County of Vaudreuil,  $4\frac{1}{2}$  miles from the village of Vaudreuil, which is the nearest railway station.

The wharf referred to and described in the report of last year has been completed.

#### PORT DANIEL.

Port Daniel, Bonaventure County, lies on the northern shore of the Baie des Chaleurs, 45 miles from Percé, and 22 miles north-east of New Carlisle.

In November, 1889, a contract was entered into for the construction of an additional length to the wharf at Port Daniel, consisting in a block of cribwork, 75 feet in length, 50 feet in width, and 27 feet in height, and the same was completed in October, 1890.

#### RIMOUSKI.

Rimouski is situated on the south shore of the St. Lawrence, in the County of Rimouski, 140 miles below Quebec.

The protection work 325 feet in length on the westerly side of the wharf and to which reference was made in my report of last year has been completed.

The south-east inclined slip has been repaired and pile sheathing commenced on the easterly side of the wharf.

#### RIVIÈRE DES PRAIRIES—ÎLE BIZARD AND STE. GENEVIÈVE—JACQUES CARTIER CO.

On the 24th October, 1889, a contract was entered into for the construction of two piers on the Rivière des Prairies, one on Île Bizard side of the stream and the other at Ste. Geneviève.

These piers are similar in construction and dimensions. They consist of 4 cribs with ice breakers, 20 by 30 feet at low water line and 20 feet square on top, placed 20 feet apart. The roadway is covered with 3 inch pine plank.

The approach on the Île Bizard side is 43 feet in length, and the other at Ste. Geneviève 76 feet, making the Île Bizard pier 206 feet in length and Ste. Geneviève 230 feet.

The work is completed.

#### RIVIÈRE DU LIÈVRE.

The Rivière du Lièvre flows into the Ottawa River 18 miles below the city of Ottawa; its general course is northerly and its width for 20 miles above the mouth varies from 300 to 600 feet.

At the Little Rapids, 12 miles above the village of Buckingham, the lock and dam which are being built are in a fair way of completion. The masonry of the lock is completed, and the gates will be shortly finished.

By the end of autumn it is expected that the dam across the river will be completed, when the water will be let into the lock and the whole work finished.

#### RIVIÈRE DU LOUP.

Rivière du Loup is situated on the south side of the St. Lawrence, 108 miles below Quebec, in the County of Temiscouata.

The works performed during the last fiscal year have been the construction of a hand-railing on the easterly side of the wharf over its whole length, and in repairing the top planking where required.

Several shoals and boulders have been removed from the channel of the river.

## RIVER L'ASSOMPTION.

The L'Assomption flows into the St. Lawrence at Repentigny.

Some improvements were made at the Chute Monte-à-peine, which is 25 miles above the town of Joliette, in the County of Joliette. They consisted in removing some points of rock and large boulders which obstructed the channel.

Some protection works to the river bank, extending over a length of 400 feet, were also constructed.

## RIVER BEAUDETTE.

This river flows through the Parish of Ste. Marie de Blandford, in the County of Nicolet, and empties into the St. Lawrence on its southern shore at Gentilly, about 15 miles below Three Rivers.

The banks of this river are very low in the vicinity of Ste. Marie de Blandford, and the bed of the river is much obstructed by trees and boulders, which keep back the water and cause the river to overflow the low-lying neighbourhood.

During the year obstructions were removed from the bed of the river, from the rapids south, for a distance of  $3\frac{1}{2}$  miles, on an average width of 25 feet.

## RIVER CHAMPLAIN.

This river takes its rise in the Parish of St. Maurice, in the County of Champlain, crosses the Parish of St. Luc and empties into the St. Lawrence on its north shore, about 14 miles below the city of Three Rivers.

The banks of this river are very high and composed of a clayey material.

Last year a landslide occurred at the village of St. Luc, which had the effect of jamming the river.

The obstructions caused by this landslide were removed over a length of  $4\frac{1}{2}$  arpents on an average width of 20 feet, which had the effect of reducing the water level 6 feet.

## RIVER MEKINAC.

The River Mekinac flows from the north and empties into the St. Maurice  $49\frac{1}{2}$  miles above Three Rivers.

There are several rapids on this river, some of which do considerable damage to the timber floating down, they being full of large boulders, which cause the jamming of the timber. At the beginning of August, some of these boulders were removed from the channel. This would have been done earlier in the season, had it not been that the water was too high to admit of the work.

During the progress of the work 1,624 boulders of various dimensions were removed with a scow and derrick; in the case of large boulders explosives having to be used.

## RIVIÈRE OUELLE.

Rivière Ouelle is 33 miles above River du Loup, and 75 miles below Québec, on the south shore of the St. Lawrence, in the County of Kamouraska.

The work done at this place, during last fiscal year, consisted in resheeting the two outer corners of the head of the wharf, and in replacing missing sheet piles where most wanted.

## RIVER RICHELIEU.

The river is about 80 miles in length and flows from Lake Champlain to the St. Lawrence through the Counties of St. John, Iberville, Chambly, Verchères, St. Hyacinthe and Richelieu, and empties into the St. Lawrence at Sorel.

In order to protect the properties at the outlet of this river and the boats which winter there from ice shoves in the spring, an additional ice breaker was built at the outlet of the river on the northern end of the western shore of the Richelieu.

The pier measures 30 feet by 24 feet at the base and 23 feet in height and stands 3 feet 11 inches above the extreme high water level, and has already proved of great service.

## RIVER ST. FRANCIS.

This river empties into Lake St. Peter on its south shore, 3 miles below the mouth of the Yamaska and 11 miles below St. Roch.

On the 27th of May, 1890, dredging was commenced opposite the wharf at St. Thomas de Pierreville, and after a good channel had been cut through the shoal, 60 feet wide and 6 feet at low water, the dredge was removed a little below to remove boulders and other impediments in the channel. These operations were brought to an end on the 31st July, 1890, at which date 15,620 cubic yards of clay and stone had been removed, at a cost of \$3,897.50 out of the appropriation for 1890-91.

The dredging done previously in the river has been of good service, the channel dredged has filled in very little.

## RIVER ST. LAVERGNE—SHIP CHANNEL BETWEEN QUEBEC AND MONTREAL.

The work done during the fiscal year consisted in the further deepening of the Ship Channel at Cap à la Reine, Poulmier Bay and Cap Charles, from its present depth of 24 feet to a full depth of 27½ feet at low water; and the commencement of the work of removing the dangerous shoals at Grandines and the Richelieu Rapids.

At Cap à la Reine three dredges and one stone lifter were engaged on the work at the point during the year. 105,438 cubic yards of shale and rock and boulders being removed at a cost of 44 cents per cubic yard.

At Poulmier Bay one dredge and one stone lifter were employed, completing the work at this point by removing 43,423 cubic yards of clay, sand, pan and boulders, at a cost of 37 cents per cubic yard.

At Cap Charles the channel was completed before the end of the season of 1890. 27,674 cubic yards of hard shale, rock and boulders were removed at a cost of 47½ cents per yard, and before the dredge was removed, the channel was thoroughly tested and found near to 27½ feet at low water.

At Grandines two dredges and one stone lifter were employed during part of the year in getting the necessary depth of 27½ feet. 27,126 cubic yards of material have been removed at a cost of 43½ cents per cubic yard. The work however at this place is not completed.

A stone lifter commenced work on Barre à Bonnard at the head of the Richelieu Rapids, and worked for a short time towards the end of the season of 1890, removing 1,214 cubic yards in 34 days.

## RIVER ST. LOUIS.

This river flows through the County of Beauharnois into Lake St. Louis, at the town of Beauharnois.

It is connected with Lake St. Francis, at the head of Beauharnois, by means of a feeder and canal, which has a width of about 20 feet and average depth of 4½ feet.

In June an easier flow in the water during freshets, and increase the volume during the dry seasons the shoal at the "Château" where the feeder was removed. A great quantity of stone and boulders were also removed in the rapids, six in number, between the bridge of St. Louis and Narcisse Laflamme's farm. This work is not completed.

## RIVER ST. MAURICE.

This river flows into the St. Lawrence at Three Rivers. It is connected with the Saguenay River by the "Canal des Rapids" and at the high water stage the water channel of the St. Maurice has, during the past season, been dredged to a depth of 10 feet at low water.

Between the 12th August and the 31st September, 1890, 2,770 cubic yards of sand were removed and dumped in the sand bar at the St. Lawrence below Doucet's Landing.

The channel dredged is 150 feet in length by 30 feet in width, with a depth of 10 feet at low water.

## RIVER VERMILION, CHUTE AUX IROQUOIS.

The Chute aux Iroquois is a fall on the River Vermilion, 4 miles from its mouth. The Vermilion is one of the chief tributaries of the St. Maurice, into which it empties 93 miles north of Three Rivers. It runs in a westerly direction, and on each side of the river are large timber limits owned by important firms.

In 1874 the main channel at the head of the Iroquois falls was closed and the eastern channel of the old slide has since been used for the descent of timber. The dam having partly given way at two places, there was not enough water flowing through the eastern channel to admit of the timber being driven through it. The dam in the main channel was repaired and raised 18 inches, and that of the side channel was closed to the same height.

## RIVER YAMASKA.

This river flows through the County of Yamaska and empties into the St. Lawrence on its southern shore, at the head of Lake St. Peter, eight miles below Sorel.

On the 14th July, 1890, an agreement was passed with Mr. J. D. Cameron for the construction of 168 feet of the Yamaska dam, to close the gap made by a break in the dam in September, 1889. The work was commenced on the 1st September and was discontinued on the 20th November, 1890. Its progress was several times retarded by the rising of the water. Four cribs were sunk, one of 50 feet in length, two of 40 feet and the last crib 38 feet. The last crib was sunk on the 6th November, and as soon as the sheet piles were driven the water commenced to rise, so that the work was delayed until the 17th November.

So soon as the planking of the last crib was completed and very little clay put above it, the work had to be discontinued owing to the appropriation being exhausted.

Dredging was also done on the river below the lock; two shoals being cut through and 16,988 cubic yards of clay and sand removed.

The dredge "Queen" commenced work in the channel above the lock on the 30th May, 1891, and at the close of the fiscal year had removed 7,744 cubic yards of material.

## ST. ALPHONSE (BAGOTVILLE).

The village of St. Alphonse, Bagotville, is situated at the head of Ha! Ha! Bay Saguenay River, Saguenay County, 12 miles from Chicoutimi.

The planking of the wharf was renewed over the western 200 feet, and a quantity of stone placed in the wharf near the centre. The cap timbers on both sides were renewed and heavy repairs were made to the movable slip.

## ST. ANICET.

St. Anicet, in the County of Huntingdon, is situated 56 miles south-west of Montreal, on the south shore of Lake St. Francis.

This pier was built in 1862. It is 300 feet in length, the width of the 200 feet nearest to shore is 18 feet and the other 100 feet, 35 feet. Last spring, the portion nearest to shore, that is, that portion which is 18 feet in width and 200 feet in length and which consists of cribs 9 by 18 feet placed 20 feet apart, was rebuilt from water line. The wharf proper is still in a much dilapidated state.

## STE. ANNE DE LA PÉRADE.

The River of Ste. Anne takes its rise in the County of Quebec, it crosses the Counties of Portneuf and Champlain and empties into the St. Lawrence on the north shore at the Parish of Ste. Anne de la Pérade, 54 miles above Quebec and 23 miles below Three Rivers. It is for the most part very shallow.

Some dredging was done at the mouth of the river. This work was in progress at the beginning of the fiscal year 1890-91, and was discontinued on the 2nd August, 1890.

The dredging consisted in a cut 3,900 feet in length and about 22 and 44 feet in width to a depth of from 4 to 6 feet at low water, necessitating the removal of 15,496 cubic yards of material.

#### STE. ANNE DE SOREL.

Ste. Anne de Sorel, in the County of Richelieu, is 3 miles below Sorel, on the southern shore of the St. Lawrence.

The land in this district is very low. It is very fertile; the soil being remarkably rich and productive. The inhabitants are all engaged in agriculture, the products of their farms finding a market in Sorel.

The construction of an additional ice pier opposite the church, was commenced on the 15th August, 1890, and was discontinued on the 31st October, owing to the appropriation being exhausted.

The pier measures 60 feet by 25 feet at bottom and 56 feet by 24 feet on the top. It is built in 7 feet of water and stands 5 feet 2 inches above water level, having an aggregate height of 12 feet 2 inches.

#### STE. ANNE DES MONTS.

Ste. Anne des Monts, Gaspé County, is on the south shore of the St. Lawrence, 108 miles east of Rimouski.

In November, 1890, a contract was entered into for the construction of an isolated block of cribwork, 100 feet in length by 46 feet in width measured on top.

At the close of the fiscal year the contractor had delivered a quantity of materials, but active operations of construction had not been commenced.

#### STE. ANNE DU SAGUENAY.

Ste. Anne du Saguenay is in the County of Chicoutimi, on the River Saguenay, opposite Chicoutimi.

The wharf has been extended a further length of 50 feet on a width of 28 feet and 25 feet in height, covered with flooring, cap timbers and mooring posts put in position. The slip on the north-east of the wharf was planked.

#### STE. FAMILLE.

Ste. Famille is on the north shore of the Island of Orleans, 17 miles east of Quebec.

During September, 1890, the top planking of the wharf was renewed and additional floor stringers placed. One of the piers supporting the floor stringers was rebuilt and new fenders were put on the end of the wharf which is now in a good state of repair.

#### ST. FRANÇOIS.

St. François is at the eastern end of the Island of Orleans, 25 miles from Quebec.

During the year the top planking of the wharf was renewed, two additional rows of stringers placed under the planking, and fenders on the outer end renewed, and the structure is now in a good state of repair.

#### ST. JEAN D'ORLÉANS.

St. Jean d'Orléans is situated on the south shore of the Island of Orleans, 18 miles east of Quebec.

During August and September, 1890, the top planking of the wharf was partially renewed and the approach repaired where necessary.

Spring tides rise 22 feet, neaps 14.

#### ST. LAURENT.

The village of St. Laurent is on the south shore of the Island of Orleans, in the County of Montmorency, 15 miles east of Quebec.

The construction of the additional length of wharfing, to which reference was made in the report of last year, has been completed, and the wharf is now 643 feet in length with a depth of 9 feet at low water spring tides at the outer end.

Spring tides rise 23 feet, neaps 14 feet 6 inches.

#### ST. MICHEL.

St. Michel, on the south shore of the St. Lawrence, is in the County of Bellechasse, 16 miles below Quebec.

The works executed during the last fiscal year, consisted in completing the 180 feet left unfinished on the westerly side of the wharf, in the fall of 1889, viz., one course of timber has been added, and the whole length of the 180 feet has been planked for a width of 20 feet, and cap pieces and fenders placed. In addition 144 feet in length of the rotten part of the wharf, shoreward, have been demolished and rebuilt, 30 feet wide, with an average height of 7 feet, and cap pieces, fenders, &c., placed.

#### ST. SIMÉON.

St. Siméon, County of Charlevoix, is on the north shore of the St. Lawrence, 108 miles below Quebec.

The construction of a cribwork block 50 by 40 feet commenced in the preceding fiscal year has been completed.

Spring tides rise 20 feet, neaps 12½ feet.

#### ST. TIMOTHÉE.

St. Timothée, in the County of Beauharnois, is situated on the south shore of the River St. Lawrence. It is 6 miles east of Valleyfield and 9 miles west of the town of Beauharnois.

During the summer of 1889, the wharf which has a length of 100 feet was extended out 45 feet, the extension being 45 by 100 feet.

With the appropriation made last session, the warehouse was enlarged and removed to a more convenient place. The approach from the main road to the wharf was raised one foot and put in a thorough state of repairs.

#### TADOUSAC (ANSE À L'EAU).

Tadousac, or Anse à l'Eau, is at the mouth of the River Saguenay, on the southern bank.

Further repairs and improvements were effected to the wharf during the fiscal year.

#### THREE RIVERS.

The city of Three Rivers is situated upon the northern bank of the River St. Lawrence, at the mouth of the River St. Maurice, and covers an area of 9 square miles. It is half-way between Montreal and Quebec (71 miles below Montreal and 68 above Quebec) and is the capital of the district.

On the 13th November, 1889, a contract was entered into with Mr. T. E. Normand, for the construction of a wharf between the Richelieu Company's wharf and that of the Harbour Commissioners.

At the beginning of the fiscal year 1890-91 the work was in progress and was completed in November, 1890.

The wharf has a frontage of 172 feet on the St. Lawrence, is 36 feet 1 inch in height, and stands 11 feet above mean low water and is 20 feet wide on top.

#### TROIS PISTOLES.

Trois Pistoles is in the County of Temiscouata on the south shore of the St. Lawrence, 148 miles below Quebec.

The block at the head of the wharf commenced last year has been completed. It is 50 feet square, with a stair 10 feet wide on each side.

## ONTARIO.

### BEAVERTON.

Beaverton is situated on the east shore of Lake Simcoe, in the electoral district of the County of Ontario.

In February last a contract was entered into for the construction of a landing pier for the accommodation of vessels plying on Lake Simcoe, and the work was completed and accepted from the contractor on the 12th June, 1891.

### BELLEVILLE.

Belleville is situated at the mouth of the River Moira, which flows into the Bay of Quinté 43 miles west from Kingston.

In September, 1890, a contract was entered into for certain dredging in the harbour, in order to give an easier and more ready egress to the waters of the Moira, and so lessen the danger of floods during spring freshets, and the work was brought to a close at the end of December.

There were removed 40,118 cubic yards of earth and 320 cubic yards of rock.

### BIG BAY—NORTH KEPPEL.

Big Bay is situated on Georgian Bay, near the entrance to Colpoys Bay, in the township of Keppel, about 13 miles north of Owen Sound harbour.

The work consisted in rebuilding, where required, the whole of the cribwork blocks from low water level to flooring, placing new stringers and corbels, and replanking the whole of the superstructure; refilling blocks with stone and constructing a crib 35 x 25 feet, and placing same inside the space between the outer crib and the adjoining one, thus giving a solid block of cribwork, 90 feet long on the east side and 65 feet on the west side. In addition, the outer corners were sheathed with hardwood, and new mooring posts placed in position.

### BOWMANVILLE.

The harbour of Bowmanville, properly called Port Darlington, is on the north shore of Lake Ontario, 40 miles east of Toronto.

At the commencement of the fiscal year the "Ontario" was working at this place, completing dredging on the 3rd July, 1890, removing 750 cubic yards of sand.

### CLAPPERTON CHANNEL.

Clapperton Channel is the main passage between Clapperton and Croker's Island, Georgian Bay, through which vessels pass from ports on the Georgian Bay to Sault Ste. Marie and Lake Superior.

This channel is obstructed by dangerous points of rocks called "Robertson's Rocks" and in order to remove these and so give a safe, navigable channel, having a depth of 15 feet at low water, the Department commenced the removal of these points of rock.

The necessary man was taken to the spot early in October, 1890, and operations were continued until 1st of November.

The rock to be removed is of the hardest kind of red granite which makes the work of drilling very difficult, but at the time mentioned, the loss of operations, good progress had been made, but a considerable amount of rock yet remained to be removed to give the depth of water required, namely, 15 feet.

### COBOCONGO.

The harbour of Cobocongo is on the north shore of Lake Ontario, 96 miles west from Kingston and 72 miles east from Toronto.

Repairs and renewals were made to the superstructure on the east and west sides of the central pier.

**GODERICH.**

Goderich is situated in the County of Huron, at the mouth of the Maitland River, about 68 miles north of Sarnia.

General repairs were made to the harbour works at this place, the expenditure amounting to \$600.

**KINCARDINE.**

Kincardine is on the east coast of Lake Huron, 31 miles north of Goderich.

At the commencement of the fiscal year the dredge "Challenge" was working at this place, in removing an accumulation of sand in the basin and along the piers, work being closed on the 21st August, 1890, at which date 17,460 cubic yards of material had been removed.

**KINGSTON.**

Kingston is at the foot of Lake Ontario, 172 miles west of Montreal.

The work of removal of Point Frederick shoal, which was in progress at the close of the last fiscal year, was continued to the 23rd October, when operations ceased for the season. It was resumed on the 26th May, 1891, and at the close of the fiscal year a further quantity of 2,629 cubic yards of rock had been removed.

**KINGSTON DRY DOCK.**

At the close of the fiscal year but little remained of the dock proper to be completed. Contracts for the pumping plant and caisson had been awarded, plans and specifications had been prepared for the engine-house and chimney, and the dock will be ready for the reception of vessels before the close of navigation.

**KINGSVILLE.**

Kingsville is in the electoral district of South Essex, on Lake Erie; it is also a station upon the Detroit, Essex and Lake Erie Railway, and is distant about 25 miles from the mouth of the Detroit River.

Some necessary general repairs were made to the landing pier, consisting, principally, of cutting off old piles, building new trestle bents, renewing stringers, and new sheathing on the end of the pier.

**LITTLE CURRENT.**

Little Current is the passage between Cloche Island and the Great Manitoulin, is on the direct road to Sault Ste. Marie for vessels taking the north channel, and is distant from Collingwood about 140 miles.

The work of widening and deepening the channel which was in progress at the close of the last fiscal year was continued until 30th September, during which time 3,775 yards of rock were blasted and removed from the channel.

During the winter of 1890 and 1891, necessary repairs and renewals were made to the plant and a new derrick scow 70 by 20 feet, with steam hoisting apparatus, was added to the plant.

**MEAFORD.**

Meaford, an incorporated town in the County of Grey, is situated on the Georgian Bay, 18 miles west from Collingwood and 20 miles east of Owen Sound.

During the past year the dredge "Challenge" was engaged on a bar at the inside of the breakwater on end of west pier and in deepening the channel between the piers, and was still working at the close of the fiscal year; 10,260 cubic yards of material having been removed.

**MIDLAND.**

Midland, Simcoe County, is the terminus of the Midland division of the Grand Trunk Railway, on the Georgian Bay.

The construction of the 2,000 feet of work on the harbour front, referred to in report of last year, was finished on the 8th July, 1890.

#### OTTAWA RIVER.

During the year the dredge "Queen" was working on shoal No. 1, three miles below the city of Ottawa, and at the close of navigation had removed 12,372 cubic yards of material.

The dredge "Nipissing" operated off Goose Island in dredging a channel to a depth of 10 feet, and at the close of navigation had removed 15,915 cubic yards of sand and sawdust.

Between the 6th and 25th of June, 1891, the "Nipissing" was engaged along the east side of wharf at St. Placide, removing 1,590 cubic yards of material. Considerable delay was caused by the breaking of the dredge owing to the hard digging.

The dredges "Nipissing" and "St. Louis" operated on the shoal below Jones' Island, and worked there up to close of fiscal year, at which date 7,910 cubic yards of clay had been removed.

The dredging of the shoal which obstructs the channel leading to the Culbute Canal was carried on during the fiscal year ending 30th June, 1891.

The dredge commenced work on the 25th August, 1890, and closed on the 4th October. During that time, 896 cubic yards of sand and gravel were removed.

The channel dredged out has a depth of 8 feet at low water, and 14 buoys have been placed on its north side, 6 of which have been put in place last season.

#### OWEN SOUND.

Owen Sound, in the County of Grey, is situated at the mouth of the Sydenham River, and is the terminus of the Canadian Pacific Railway, on the Georgian Bay.

A contract was entered into for dredging and other improvements in the harbour, and but little work was done, when in May, 1890, the contractor was relieved of the work and it was awarded the next lowest tenderers.

At the close of the fiscal year 1890 the contractors had delivered a large amount of material and were getting their plant in readiness for active operations, which were commenced in August, 1890, and by the 30th June, 1891, the pile protection work had been nearly completed, and a large amount of dredging and excavation performed.

The "Challenge" having been ordered for work in the harbour at Owen Sound, left Meaford on the 8th June, 1891, and worked there until the 20th, removing a shoal at the outer range light, at which date 3,360 cubic yards of material had been removed.

#### PARRY SOUND NARROWS.

These narrows are situated respectively 7 and 2 miles south of Parry Sound, and form a portion of the channel called the North or Inner Channel of Georgian Bay, usually taken during rough weather and in the autumn by steamboats plying between Midland, Penetanguishene and Parry Sound.

At low water both these channels are impracticable to boats drawing over 5 feet, and it often happens, when heavily laden, they are obliged to follow the outside channel regardless of weather.

To obviate this necessity of taking the outside channel, the Department during the fiscal year commenced the necessary work of improvement to give a depth of 8 feet at lowest stage of water in Lake Huron.

The work was commenced on the 1st June, 1891, and was in progress at the close of the fiscal year.

#### PENETANGUISHENE.

Penetanguishene Harbour is situated on the north of the eastern peninsula in Georgian Bay, formed between Nottawasaga Bay and the waters of the Severn River.

To give a better depth of water in the harbour, from which large quantities of lumber are shipped to other points, the Department secured the services of a dredge which worked until 4th August, 1890, removing 18,750 cubic yards of material, and thus improved the harbour to a large extent.

#### PICKERING, FRENCHMAN'S BAY.

The harbour of Pickering, formerly known as Frenchman's Bay, is situated on Lake Ontario, 21 miles east of Toronto.

During the year the "Ontario" did some work on the channel running from the piers to elevator at the wharf, and removed an old sunken pier, which was a great obstruction to vessels; work being closed on the 5th August, 1890, at which date 12,000 cubic yards of sand, mud and gravel had been removed.

#### PORT ALBERT.

Port Albert is situated at the mouth of Nine Mile Creek, which empties into Lake Huron, 9 miles north of Goderich.

During the year the "Challenge" was engaged in making a channel through a sand bar which had formed between the piers, removing 4,860 cubic yards of material.

#### PORT ARTHUR.

Port Arthur is situated at the head of Thunder Bay, Lake Superior, and is one of the ports of call for the Canadian Pacific Railway steamers and other lines plying on Lake Superior.

The work under contract with Messrs. Kirby & Stewart, to which reference was made in the report of last year, was completed in November, 1890.

A large quantity of extra stone talus was placed in front of the breakwater, sheet piling was constructed round the ends of the blocks and repairs were made to the other parts of the structure where required.

#### PORT ELGIN.

Port Elgin is in the electoral division of the northern portion of the County of Bruce, on the eastern shore of Lake Huron, about 24 miles north of Kincardine.

Repairs were effected to the pier and breakwater, a quantity of stone and brush being deposited to protect the breakwater, while the pier was replanked over a length of 105 feet and protected with longitudinal guards.

#### PORT HOPE.

Port Hope is on Lake Ontario, 7 miles west of Cobourg and 107 from Kingston.

Repairs and renewals were effected to the east pier and coal wharf, as well as to the eastern side and end of the railway wharf in the inner harbour.

#### PORTSMOUTH.

Portsmouth is situated on Lake Ontario, 2 miles west from Kingston.

The work of rebuilding the superstructure of the pier at this place was completed in August, 1890, and the structure is now in good condition.

#### RIDEAU RIVER—NORTH BRANCH.

At the commencement of the fiscal year the dredges "Queen" and "St. Louis" were working in making a channel and basin in front of the proposed wharf to join the channel to Rideau Canal, to a depth of 7 feet; 5,575 cubic yards of material being removed.

#### RIVER KAMINISTIGUIA.

This river empties into Thunder Bay, Lake Superior, to the west of Port Arthur.

A further amount of dredging was done on the bar which lies off the mouth of the river, and also in the river itself, to accommodate the large steamers which now call at Fort William to load with grain for shipment by rail at other ports.

## RONDEAU.

Rondeau Harbour, is situated on the north shore of Lake Erie, about 140 miles West of Port Colborne, the Lake Erie entrance to the Welland Canal; it is a harbour of refuge.

During the past year extensive repairs and renewals were effected to the east pier which was in a very bad state, and there still remains a considerable portion of the structure in a most unsafe condition.

## SARGEEN.

Sargeen River empties into Lake Huron at the village of Southampton. The mouth of the river is used as a harbour for fishing craft and tug boats.

The mouth of this river being obstructed by boulders and other obstructions, the services of a dredge were obtained resulting in the removal of 6,700 cubic yards of material, besides a large number of boulders. Good ingress and egress can now be obtained by vessels.

## SHANNONVILLE.

Shannonville is situated on the Salmon River which empties into the Bay of Quinte about 6 miles from Belleville and 4½ miles west of Kingston.

Between the 6th September and 13th October 1890, the "Ontario" was engaged at a bar in the mouth of the Shannon River removing 15,800 cubic yards of material.

## SOUTHAMPTON.

Southampton, in the county of Kent, is situated at the mouth of the Sargeen River which empties into Lake Huron 24 miles above Sarnia, and is the terminus of the Wellington, Grey and Bruce branch of the Grand Trunk Railway.

Reclamation work was done by the extension of the landing wharf and the construction of a new wharf and a breakwater.

## SOUTHAMPTON.

The Sargeen River is a small stream which empties into the passage between the two islands of the Sargeen River. The river divides into two branches, the Sargeen River and the Sargeen River, the latter being 15 miles long.

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**TRENTON.**

Trenton is at the head of the Bay of Quinté, 60 miles above Kingston and 12 from Belleville.

The dredges "Ontario" and "St. Louis" operated at this place during the past year on the new channel through a shoal between the town of Trenton and the Murray Canal; 11,350 cubic yards of material being removed.

**WHITBY.**

The harbour of Whitby, formerly Windsor Harbour, is on the north shore of Lake Ontario, about 135 miles above Kingston and 30 from Toronto.

The "Ontario" arrived at this place on the 7th August, 1890, and commenced work on a channel through the harbour on the east side of west pier, and in front of lumber dock, removing 9,930 cubic yards of material. Considerable delay was caused here, owing to the high winds and heavy sea.

**WIARTON.**

Wiarton is a very prosperous town in the County of Bruce, situated at the head of Colpoy's Bay (Georgian Bay), about 32 miles north of Owen Sound. It is the terminus of the Georgian Bay and Lake Erie branch of the Grand Trunk Railway.

The harbour is a natural one, extending 8 miles from its entrance to the town. It is protected at the mouth by three large islands—White Cloud, Griffith and Hay. The water is deep to within a few feet of the shore, and the harbour has not a reef, bar or shoal in its whole area.

The construction of a breakwater 380 feet in length, near the head of the harbour on the west side, to afford protection to small craft, was completed on the 17th July, 1890.

It having been decided to extend this breakwater a further length of 220 feet, a contract was entered into for the work in question, and the same was completed in October, 1890.

Fenders were placed along the southern side of the breakwater, and a further quantity of stone was placed in the talus at the outer end to prevent scour.

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**MANITOBA.****RED RIVER.**

Dredging was continued in the lake at the mouth of the river, and the channel in the river near what is known as Salimony's Channel, where the water is very shallow, was deepened.

The lake boats had no difficulty in making the mouth of the river through the dredged channel, even in the roughest weather.

**THE WHITE MUD.**

The mouth of the White Mud River is 9 miles north of Westbourne, in the County of Marquette. Westbourne is on the Manitoba and North-Western Railway, and is a place of transshipment to and from the lake in connection with the lake trade.

During the year, the dredge "Priestman" was engaged in opening up the outer end of the channel, which had somewhat filled in, giving five feet of water throughout. It was then placed to widen the mouth of the channel, the intention being to give a width of 300 feet at the entrance.



General repairs and improvements were effected to the works and plant by the dock staff; drains, pumps, wells, &c., were cleaned, and in fact the dock and dock premises were kept in good order.

A coal shed 58 x 36 feet, divided into four compartments, was constructed by the dock staff.

#### FRASER RIVER.

The Sand Heads at the mouth of the Fraser River extend about 5 miles into the Strait of Georgia.

The improvement of the channel across the Sand Heads was continued during the fiscal year, the north and south dams being extended.

The snag boat "Samson" was also engaged during the year in removing snags from the river.

#### NICOL ROCK.

The harbour of Nanaimo is situated on the east coast of Vancouver Island, 73 miles from Victoria, with which it is connected by rail.

Nicol Rock, lying about 450 feet north-west from the wharf of the Vancouver Coal Company, and about 120 feet east of their ballast wharf, was a danger to shipping, and the Department has been engaged for some time in removing the same to a depth of 16 feet at ordinary low water springs, and operations were continued thereon during the past fiscal year.

#### NICOMECKLE RIVER.

The channel of this river was cleared of obstructions, and overhanging brush removed from its banks.

#### VICTORIA HARBOUR.

During the past fiscal year, the work of improving Victoria Harbour was continued, a commencement being made in removing Pinnacle Rock, lying opposite to and 500 feet from the wharf front.

About 200 cubic yards of rock have been removed, but there still remains a small area to be blasted and removed, to give a depth of 14 feet at ordinary low water springs.

The dredge "Pacific" was engaged during the year, in widening and deepening the entrance to the harbour, abreast of "Shoal Point," with the most satisfactory results.

### SURVEYS AND EXAMINATIONS.

During the year surveys and examinations were made at the undermentioned localities; and with some exceptions, plans, reports and estimates have been submitted:—

Long Point,	King's Co.	P.E.I. Cocagne,	Kent Co.	N.B.
St. Peter's Bay	do	Campbellton,	Restigouche Co.	do
Summerside,	Prince Co.	do Dalhousie	do	do
Bay View,	Queen's Co.	do Fort Dufferin, Negro Point		
Belfast	do	do Breakwater,	St. John Co.	do
Cape Traverse	do	do Gardner's Creek	do	do
China Point	do	do Quaco	do	do
Hope River	do	do West Quaco	do	do
Hunt's Point	do	do River St. John, Grand Falls,	Victoria Co.	do
New London	do	do Baie Verte,	Westmorland Co.	do
Wood Islands	do	do Cape Tormentine	do	do
Anderson's Hollow,	Albert Co.	N.B. Dover	do	do
Coverdale	do	do Pointe du Chêne	do	do
Edgett's Landing	do	do Margaretville,	Annapolis Co.	N.S.
Halburst,	Gloucester Co.	do Hampton	do	do
Belledune	do	do Port Lorne	do	do
Clifton	do	do Arisaig,	Antigonish Co.	do
Grand Anse	do	do Bayfield	do	do
Tracadie	do	do Georgeville	do	do

[illegible]

ground 40 fathoms by 72 feet, inside up to and along wharf 458 fathoms, by 70 feet average width, and a basin 500 feet long by 150 feet wide at western front of railway wharf, the whole to a depth of 16 feet at low tide.

The quantity removed was 35,950 cubic yards, consisting principally of mud and oyster beds.

Orders were received to send dredge to Sissiboo River, Weymouth, Digby County N.S., and work was closed at Point du Chêne on 24th October. Dredge left 25th for Weymouth. The passage after coaling at Pictou was long and stormy, the season was late, and when Weymouth was reached and the dredge finally got to work it was found impracticable to continue, and it was finally ordered to St. John, N.B., to repair 6th December. Only 88 cubic yards of boulders were removed in the trial at Weymouth and the bottom appeared to be either boulders or a ledge covered with a thin layer of sand.

On the arrival of the dredge at St. John, N.B., it was placed in winter quarters, the engines and machinery examined and placed in working order, new tubes were placed in boiler and other necessary repairs effected to make it available for another season's work. The old buckets, links and tumblers were removed and new ones, constructed last year, put in place and other improvements effected.

The dredge left St. John on 3rd June and arrived at Richibucto, Kent County, N.B., on the 12th, when it was placed to work at the Albion or Middle Channel, and is now, at the close of the year, improving the same, 1,313 cubic yards of fine sand having been removed.

The total quantity removed by the "St. Lawrence" during the year is 47,331 cubic yards, costing 32.524 cents per cubic yard.

#### "CANADA."

The dredge "Canada" on 1st July was working at Mabou, Inverness County, N.S., and continued there till 10th November, except from 6th to 24th October, when it was at Pictou for repairs.

At Mabou a cut 240 feet long, 100 feet wide, was made alongside of the breakwater, leaving a depth at low water of 12 feet. Off the end of the breakwater, where 12 feet depth was obtained, a cut 1,840 feet long was made, from 55 to 85 feet in width, continuing the depth to 12 feet L. W. S.

At the site of the proposed new wharf a cut 200 feet long, 50 feet wide, and 3 feet deep, was made, leaving 13 feet L. W. S., the material removed being principally mud and sand. The amount excavated at Mabou in the above mentioned period was 20,700 cubic yards of gravel, clay, stone, sand and boulders.

At Pictou market wharf, where dredge operated 26 days in November and December, previously to going on marine slip for winter berth, 1,800 cubic yards of mud were taken out.

Length of cut 250 feet, 50 feet wide, over which 4 feet were taken off leaving 12 feet L. W. springs.

This dredge was placed on the marine slip at Pictou and wintered. The engine, boiler and machinery were examined and placed in working order. The old belting around dredge removed, new and larger belting put on, rudder new plated and repaired.

While at Mabou last fall the vessel touched on the rocks and injured her bottom. Several plates and angle irons were found broken, all of which were removed and new plates and angle irons put in, also two new water tanks.

On 15th May the dredge came off the slip and made preparations for getting to work, and when fitted out worked for 3 days from 19th to 21st May, at Dwyer's wharf, Pictou, N.S., removing 720 cubic yards of mud. Orders were received that dredge be sent to Mabou, N.S., and on 24th May the dredge left Pictou for that place, arriving on 25th.

Work was commenced next day and at the end of the year was in progress, at which time a further quantity of 6,930 cubic yards of sand had been removed, improving and deepening the work of last season.

The total quantity removed by this dredge during the year was 30,150 cubic yards costing 39-526 cents per cubic yard.

#### "NEW DOMINION."

In July the above dredge was at work on the Kennebecasis River, King's County, N.H., at Perry's Point remaining till 15th September when Land's Point was taken up on the other side of the bridge in the river. The work consisted in deepening and straightening the channel of the river at these places.

At Perry's Point by 15th September a cut 420 feet long by 50 feet, and 14 feet deep, in it and through the western draw of the bridge was made and one cut 700 feet long by 45 and 22 feet deep at the point and a second cut 250 feet by 100 wide in front of which it is proposed to build a wharf, also a basin 30 by 40 feet at upper end and 20 by 60 feet at lower end of proposed wharf for swinging vessels, a further quantity of 27,620 cubic yards of sand and mud being removed.

At Land's Point from 15th September till 15th November 21,110 cubic yards of gravel, sand and silt were removed, it making a cut 1,100 feet long 45 wide and 22 feet deep. The season getting late the dredge was ordered into winter quarters at St. John, N.H., on the 15th November.

During the winter the engine, boiler, machinery and screws were examined, repaired and made ready for work.

In the spring the dredge commenced work at Hamilton, Kennebecasis River, King's County, N.H., and after being made ready at the shopyard it was towed on the 1st May to the place named.

The work at Hamilton was deepening the channel over a length of 700 feet, 45 feet wide at a depth of 5 feet, 100 feet wide at 12 feet.

The work getting late in the season the dredge was ordered to be repaired and after being repaired the work was resumed at the same place. The dredge was ordered to be repaired and after being repaired the work was resumed at the same place. The dredge was ordered to be repaired and after being repaired the work was resumed at the same place.

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channel was only 30 feet wide before the dredging commenced, giving a depth of 7 feet at L. W. springs.

At Tatamagouche, Colchester County, N. S., which place the dredge reached 30th July, work was under way by 4th August, and closed 12th September, and consisted in making a basin in front of Patterson's wharf, 360 feet long, 160 feet wide at outer end and 80 feet at inner end, 7 feet deep L. W. S.; a channel 378 feet by 30 feet, up to Campbell's wharf, and from the forks to Campbell and Patterson's basin a channel 376 feet by 45, the total quantity excavated being 7,755 cubic yards of mud and clay.

Orders were given for the dredge to proceed to Cheticamp, Inverness County, N. S. After detention on account of storm that place was reached and work commenced 22nd September and continued till 7th November, when the dredge was placed in winter quarters.

During the winter repairs were made to engines, boiler, machinery and scows, and on 3rd June the dredge resumed work at Cheticamp widening and deepening the channel, the dimensions of work being a cut along side of former channel 1,100 feet long by 40 wide, 14 feet deep L. W. springs, where the depth before dredging ranged from 8 to 12 feet deep.

Up to the close of the fiscal year the quantity of kelp, seaweed and sand removed was 8,655 cubic yards, and the work is being further prosecuted.

The total quantity removed by this dredge during the year is 21,480 cubic yards, at a cost of 43.070 cents per cubic yard.

#### "THE CHALLENGE."

On the 2nd July, 1890, the dredge "Challenge" and plant was working at Kincardine, Ont., removing an accumulation of sand in the basin and along the piers. Two cuts were made along the north pier, one 1,385 feet long, 25 feet wide, extending from the bridge to the outer end of pier, and a second cut 800 feet long, 25 feet wide, from the basin to outer end of pier to a depth of 13 feet in the basin and 16 feet between the piers. One cut was also made along west side of harbour, 500 feet long, and one cut along south side 285 feet long, to a depth of 13 feet. 17,460 cubic yards of ordinary sand and mud was removed.

The plant left Kincardine on the 21st August for Port Albert, but, owing to the extreme high winds, had to put into Goderich for shelter, and only began operations at Port Albert on the 25th and worked there up to the 30th September, making a channel through a sand bar which had formed between the piers. One cut was made 500 feet long, 25 feet wide and 10 feet deep, removing 4,860 cubic yards of ordinary sand, gravel and clay.

Owing to the prevailing high winds and exposed position of this harbour, causing great loss of time, operations at this place were discontinued and the dredge taken to Meaford, Ont., beginning work there on the 9th October on a bar at the inside of breakwater on end of west pier, making one cut 200 feet long, and one 175 feet long, leaving a channel 45 feet wide, with a depth of 15 feet at low water. Also made two cuts on west side of basin. One 475 feet long, and one 275 feet, 13 feet deep, 4,320 cubic yards of clay, hard-pan and clay being removed.

On the 24th October, the plant was towed to Collingwood, Ont., and laid up for the winter.

In the spring of 1891, the plant was taken to Meaford, Ont., and commenced operations there on the 20th May, deepening the channel between the piers, and worked there up to the 8th June, when the plant was ordered to Owen Sound, to remove a sand shoal at the outer range light, and worked there until the 20th, making one cut 600 feet, and one 300 feet long, leaving a channel 150 feet wide, with 16 feet of water at outer light. The material removed consisted of 3,360 cubic yards of ordinary sand. Operations were resumed at Meaford on the 22nd June, and continued up to the close of the fiscal year, making a cut 675 feet long and 25 feet wide, to a depth of 15 feet. 200 feet of this cut was done last autumn, but owing to the loose nature of the deposit, had filled up again

to a considerable extent. 5,940 cubic yards of hard-pan and gravel were removed, making a total of 10,260 cubic yards removed at this place during the fiscal year.

During the winter of 1890-91, the dredge and tug were overhauled and repaired at the dry dock, Collingwood. A thorough repair was also given to the boiler of the tug. This plant is now in fair condition, except the hull of the tug, which will require rebuilding at an early date.

The total quantity removed by the "Challenge" during the year is 35,940 cubic yards; cost,  $21\frac{3}{4}$  cents per cubic yard.

#### "NIPISSING."

On the 2nd July, 1890, this dredge was working at Lachine, Que., making three cuts in front of the local wharves, one cut 168 feet long, one cut 200 feet long, and one cut 378 feet long, to a depth of 8 feet; 2,385 cubic yards of mud, clay and stone, and boulders being removed.

The plant was next towed to Beauharnois on the 16th July, and commenced work, digging up old piers and cribwork and deepening channel in front of the village wharves to 10 feet, removing 12,060 cubic yards of clay, clay and stone and boulders.

On the 25th August, the plant was towed to Shoal No. 4 (near Goose Island), Ottawa River, and worked there up to the close of navigation, making two cuts 2,530 feet long and 25 feet wide, and one cut 800 feet long and 25 feet wide to a depth of 10 feet.

The materials removed consisted of 15,915 cubic yards of ordinary sand, mixed with sawdust.

On 4th November, the plant was towed to Ottawa, and laid up for the winter in the Rideau Canal basin.

After the usual outfitting and repair in the spring of 1891, the dredge and plant was taken to the Lake of Two Mountains, on 25th May, and commenced work on the clay shoal below Jones Island, and worked there until the 6th June, when the plant was removed to Ste. Placide, making two cuts along east side of wharf, 112 feet long, to a depth of 8 feet, removing 1,590 cubic yards of hard-pan and boulders.

Considerable delay was caused at this place by the breaking of the dredge machinery owing to the hard digging.

On the 25th June, the dredge resumed work on the shoal below Jones Island and worked there up to close of the fiscal year, removing 2,460 cubic yards of clay.

This plant is in good condition and will require very little expenditure for some years beyond ordinary repairs.

The total quantity removed by the "Nipissing" during the year is 34,410 cubic yards, at a cost of  $20\frac{3}{4}$  cents per cubic yard.

#### "THE ONTARIO."

On the 2nd July, 1890, the dredge "Ontario" and plant was finishing work at Bowmanville, Ont., removing 780 cubic yards of ordinary sand. Completed work there on the 3rd and towed to Frenchman's Bay (Pickering, Ont.); commenced work on the 4th and continued there up to the 5th August, making two cuts between the piers out to deep water, 775 feet long, 50 feet wide and 12 feet deep. Also belled off one side of channel running from piers to elevator at the wharf and removed an old sunken pier which was a great obstruction to vessels, and removed 12,000 cubic yards of sand, mud and gravel.

The plant was next taken to Whitby, Ont. Commenced operations there on the 9th August, making two cuts through the harbour on the east side of west pier, 975 feet long, 50 feet wide, to a depth of 12 feet. Also belled off inner end of cuts in front of lumber dock, removing 9,930 cubic yards of sand.

Considerable delay was caused here owing to the high winds and heavy sea.

On the 2nd September the dredge and plant was towed to Shannonville, and commenced work on the 6th on a bar at the mouth of the Shannon River, making two cuts 1,270 feet long, 50 feet wide, to an average depth of  $11\frac{1}{2}$  feet. Also made one

cut through first bend in the river 200 feet long, by 25 feet wide, removing 13,830 cubic yards of clay, sand, mud and gravel.

A considerable quantity of sawdust and logs were also removed at this place.

The plant left Shannonville for Trenton on the 15th October, arrived there on the 17th, and commenced work on the new channel through a shoal between the town of Trenton and the Murray Canal, made one cut 1,050 feet long, 25 feet wide at bottom, and giving a depth of  $8\frac{1}{2}$  feet at low water, and removed 5,000 cubic yards of clay, mud, boulders and gravel.

On the 13th November, at the close of navigation, the plant left Trenton and arrived at Belleville on the 17th where it was laid up for the winter.

In the spring of 1891, the plant was towed to Trenton and resumed operations on the 16th May, cutting new channel through the shoal and worked there up to the 10th June, when the plant was taken to Picton, Ont., and placed on the dry dock where a thorough caulking and repair was given to the hulls of dredge, tug and both scows. On the 27th June, the plant was towed back to Trenton, and worked there up to close of the fiscal year, removing 5,225 cubic yards of clay, gravel, boulders and mud, making a total of 10,225 cubic yards of material taken out at this place during the fiscal year.

One new scow was added to this plant during the season and the general condition of the dredge and tug is good.

The total quantity removed by the "Ontario" during the year is 46,765 cubic yards, at a cost of  $18\frac{1}{2}$  cents per cubic yard.

#### "THE QUEEN."

On the 2nd July, 1890, this dredge was working on the north branch of the Rideau River at Kemptville, Ont., making a channel and basin in front of proposed wharf to join channel to Rideau Canal to a depth of 7 feet, removing 2,575 cubic yards of clay, mud, hard-pan and boulders.

The plant was taken to the Ottawa River on the 17th September and commenced work on Shoal No. 1, three miles below the City of Ottawa, and worked there up to the close of navigation, making one cut 2,400 feet long, and one cut 1,250 feet long, to a depth of 10 feet, removing 12,372 cubic yards of ordinary sand.

On the 3rd November, the close of navigation, the plant was towed to Ottawa and laid up for the winter in the Rideau Canal basin.

After the usual outfitting and repair, the plant left Ottawa on the 23rd May, 1891, and was towed to Yamaska River, where it commenced work in the channel above the lock on the 30th, making two cuts of 625 feet long, to a depth of 7 feet, and one cut below the lock 875 feet long, to the same depth, removing 7,744 cubic yards of ordinary sand, fine sand and clay.

The plant was still working there at the close of the fiscal year.

Owing to the hard digging at Kemptville, considerable repairs were required and given this dredge during the past winter. The plant is now in a fair condition, except the boiler of the tug "Sensation" (tender for this dredge) which is very old, requiring frequent repair and curtailing of the steam pressure. A new boiler is absolutely necessary.

The total quantity removed by the "Queen" during the year is 22,691 cubic yards, at a cost of  $33\frac{1}{2}$  cents per cubic yard.

#### "ST. LOUIS."

On the 2nd July 1890, this dredge was working in conjunction with the dredge "Queen" at Kemptville, Ont., dredging a basin in front of proposed wharf to a depth of 7 feet, and remained there up to 2nd August, removing 3,000 cubic yards of clay and ordinary sand.

The plant was next towed to the Lake of Two Mountains, Que., and commenced work on the shoal below Jones Island, making one cut 1,500 feet long, 25 feet wide and 10 feet deep, removing 5,450 cubic yards of sand.

In the Fall, October the pump was moved to Ottawa, and laid up for the winter in the main house.

This design having been built for special work on the St. Louis feeder, was found to be too small for lake and river service, consequently during the spring of 1891, a somewhat new hull was built and a thorough overhaul given to the machinery, after which the pump was taken to Evanston, Ill., to work in conjunction with the design "Chicago" on the new channel through which, between the town of Evanston and the Chicago Canal, and worked there in to the close of the fiscal year, making 12,000 cubic feet and removing 1,200 cubic yards of mud.

The design and screws are in good condition, but the hull of the tug "Davis" because of this design is in a very miserable condition, and will require rebuilding at an early date.

The total quantity removed by the "St. Louis" during the year is 1,175 cubic yards, and 1,200 cubic yards by other tug.

#### THE "WINNIEPESAU"

Work on this tug was begun in the month of the Ice River commenced last July and was completed in November.

The design is a modified version of the design of the "St. Louis" but is more satisfactory. It is 100 feet long, 12 feet wide, and 12 feet deep. The hull is of steel, and the machinery is of iron. The engine is a vertical cylinder, and the pump is a horizontal cylinder. The tug is capable of working in the ice, and is used for the purpose of removing the mud from the channel.

The tug was built by the Chicago & North Western Railway Company, and is now in the service of the Chicago & North Western Railway Company.

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### THE "SAMSON."

The snag-boat "Samson" was employed during the year in removing the snags from the channel of the Fraser, and also in seeing that the buoys marking the channel across the sand heads were in their proper places.

During the past year the "Samson" lifted and placed ashore 121 snags, which were obstructing navigation and interfering with the salmon nets.

Various necessary repairs were made to the hull and machinery, and the plant put in good order.

### DREDGING PLANT.

The dredging plant belonging to the Department is as follows:—

#### *In the Maritime Provinces.*

The steam hopper dredge "St. Lawrence.

do do "Canada."

The dipper dredge "New Dominion," and 8 scows.

do "Prince Edward," and 6 scows.

do "Geo. McKenzie," 5 scows and 1 water scow. Also five old scows belonging to the lost dredge, "Cape Breton."

One stone scow, boiler, engine, derrick and grips.

#### *In Quebec.*

The dipper dredge "Queen," 2 scows and tug "Sensation."

do "Nipissing," 2 scows and tug "Ottawa."

do "St. Louis," 2 scows, living scow and tug "Davis."

The sand dredge "Octopus."

Stone lifters, Nos. 1 and 2.

#### *Ship Channel, River St. Lawrence.*

Six elevator dredges, tugs "John Pratt," "St. James," "St. Francis," "St. Paul," "C. J. Brydges," "Minnie Parsons," "Delisle," three stone lifters, two coal barges, one stone ship, twelve dump scows of eighty yards capacity, five scows of 150 yards capacity, one sounding scow and two flat scows.

#### *In Ontario.*

The dipper dredge "Challenge," 2 scows and tug "Trudeau."

do "Ontario," 2 scows and tug "Sir John."

#### *In Manitoba.*

Dredge "Winnipeg," tug "Sir Hector" and two scows and one coal barge.

Dredge "Priestman," tug "Victoria" and two scows.

#### *In British Columbia.*

The elevator dredge "Pacific," scows and tug "Princess."

The snag boat "Samson."

Financial Statement of disbursements of the Bridge "St. Lawrence," during the Year ending 30th June, 1891.

Particulars	To Balance b/d		By Cash		By Cheque		By Order		By Transfer		By Other		By Total		Grand Total
	£	s	£	s	£	s	£	s	£	s	£	s	£	s	
Wages	210	10			200	00			270	30			470	30	5,147 96
Coal	200	00			200	00			270	30			470	30	620 25
Provisions	200	00			200	00			270	30			470	30	2,254 03
Repairs	200	00			200	00			270	30			470	30	1,676 25
Expenses of					200	00			270	30			470	30	563 00
Wages					200	00			270	30			470	30	1,222 47
Provisions					200	00			270	30			470	30	17 55
Repairs					200	00			270	30			470	30	2,444 05
Expenses of					200	00			270	30			470	30	206 50
Wages					200	00			270	30			470	30	337 15
Provisions					200	00			270	30			470	30	66 28
Repairs					200	00			270	30			470	30	14,144 53
Expenses of					200	00			270	30			470	30	2,155 23
Wages					200	00			270	30			470	30	10,285 87
Provisions					200	00			270	30			470	30	108 32
Repairs					200	00			270	30			470	30	8,730 34
Expenses of					200	00			270	30			470	30	14,144 53

## CLASSIFICATION OF DISBURSEMENTS OF THE DREDGE "CANADA," DURING THE YEAR ENDING 30th JUNE, 1891.

Items	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Grand totals.
	£ cts.	£ cts.	£ cts.	£ cts.	£ cts.	£ cts.	£ cts.	£ cts.	£ cts.	£ cts.	£ cts.	£ cts.	£ cts.
Wages.....	408 21	390 33	390 33	390 33	390 33	347 88	230 33	230 33	286 38	687 59	400 88	480 33	4,633 25
Coal.....	110 40	110 40	145 48	145 48	27 60	.....	111 18	.....	50 70	99 86	55 20	188 89	527 57
Provisions.....	63 44	39 72	119 83	139 24	.....	.....	.....	.....	80 20	35 44	61 82	246 30	931 09
Stores.....	83 89	83 89	.....	.....	.....	.....	13 15	17 60	.....	6 00	.....	.....	220 99
Equipment.....	4 40	4 40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	41 15
Water.....	1 00	1 00	.....	492 12	.....	221 74	5 00	.....	15 05	.....	184 63	2,192 65	3,137 73
Repairs.....	30 54	1 00	.....	30 00	42 50	.....	.....	.....	389 60	65 60	118 40	501 78	1,076 38
Pilotage.....	67 50	55 00	65 00	.....	.....	.....	17 52	.....	.....	9 30	.....	12 33	57 45
Towage.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wharfage.....	.....	8 34	9 96	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Contingencies.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Totals.....	569 69	694 08	730 10	1,073 15	460 43	569 62	377 18	247 93	821 93	904 79	827 93	3,622 28	10,899 11
Working expenses.....	539 15	693 08	730 10	581 03	460 43	347 88	377 18	247 93	130 90	115 16	524 90	915 52	5,663 26
Repairs, ordinary.....	30 54	1 00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	31 54
do extraordinary.....	.....	.....	.....	492 12	.....	221 74	.....	.....	691 03	789 63	303 03	2,706 76	5,294 31
Total.....	569 69	694 08	730 10	1,073 15	460 43	569 62	377 18	247 93	821 93	904 79	827 93	3,622 28	10,899 11



## CLASSIFICATION OF DISBURSEMENTS OF THE DREDGE "PRINCE EDWARD" DURING THE YEAR ENDED 30TH JUNE, 1891.

Items.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Grand Totals.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.
Wages.....	497 75	494 50	494 50	517 17	339 41	157 50	157 50	150 00	155 00	267 00	155 00	228 68	3,614 01
Coal.....	224 54	110 40	209 00	14 98									558 92
Provisions.....													
Stores.....	28 04			25 34	57 30		52 74					20 00	183 42
Equipment.....							3 23						3 23
Water.....	40 00	40 00	44 00	40 00	40 00		14 45			5 00			223 45
Repairs.....	32 27	14 50	14 50	12 50	47 00		128 00	10 60	4 60		226 20	233 40	729 07
Pilotage.....												5 00	5 00
Towage.....						2,761 25							2,761 25
Wharfage.....													
Contingencies.....							9 00					40 00	49 00
Totals.....	822 60	644 90	762 00	609 99	483 71	2,918 75	364 92	160 60	159 60	272 00	381 20	547 08	8,127 35
Working expenses.....	790 33	644 90	747 50	597 49	436 71	2,918 75	236 92	150 00		5 00		233 68	6,761 28
Repairs, ordinary.....	32 27		14 50	12 50			128 00	10 60					197 87
do extraordinary.....					47 00				159 60	267 00	381 20	313 40	1,168 20
Totals.....	822 60	644 90	762 00	609 99	483 71	2,918 75	364 92	160 60	159 60	272 00	381 20	547 08	8,127 35



## CLASSIFICATION OF DISBURSEMENTS OF THE DREDGE "NIPissing," DURING THE YEAR ENDED 30th JUNE, 1891.

Items.	July.		August.		September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Grand totals.
	\$	cts.	\$	cts.	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
Wages .....	346 50		346 50		321 00	515 00	122 00						305 48	293 50	2,249 98
Coal .....	723 65		450 20										312 00		1,485 85
Wood .....						91 26	31 95				85 20		34 58	92 70	564 91
Provisions .....	108 68		100 00		105 74		5 20						36 69		235 68
Stores .....													56 25		171 20
Equipment .....															
Repairs .....	89 05				66 85		255 74	190 80	189 53	237 60	401 82	568 71	248 57	69 05	2,347 72
Pilotage .....															
Towage .....	19 35		42 75		16 41	5 35	1 45					14 27	5 00		5 00
Contingencies.....															
Totals .....	1,287 23		939 45		510 00	611 61	416 34	190 80	189 53	237 60	487 02	836 52	998 57	478 42	7,183 09
Working expenses .....	1,108 18		939 45		443 15	611 61	160 60				85 20	237 81	750 00	409 37	4,835 37
Repairs, ordinary .....	2 10				66 85		255 74	13 23			111 15	257 24	158 25	7 36	871 92
do extraordinary .....	86 96							177 57	189 53	237 60	290 67	341 47	90 32	61 69	1,475 80
Totals .....	1,287 23		939 45		510 00	611 61	416 34	190 80	189 53	237 60	487 02	836 52	998 57	478 42	7,183 09



CLASSIFICATION OF DISBURSEMENTS OF THE DREDGE "QUEEN," DURING THE YEAR ENDED 30TH JUNE, 1891.

Items.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Grand Totals.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.
Wages .....	271 26	294 42	292 34	432 59	114 32					190 84	292 82	333 50	2,222 09
Coal .....	182 00	192 90	416 00		50 00						375 40		1,216 30
Wood .....												2 50	2 50
Provisions .....	90 00	90 00	91 50	90 00	30 90						35 63	97 00	525 03
Stores .....	7 29	28 80		5 50	60				71 10		21 77		236 48
Equipment .....		17 71		3 60						101 42	76 10		167 78
Repairs .....	16 45	347 60	87 46		297 87	203 92	189 54	237 60	407 95	723 96	359 29		2,871 64
Pilotage .....											7 00		7 00
Towage .....													
Contingencies .....	4 84	8 89	108 89	6 79	1 60					13 60	100 00	1 67	246 28
Totals .....	571 84	980 32	996 19	538 48	495 29	203 92	189 54	237 60	479 05	1,105 92	1,262 26	434 67	7,495 08
Working expenses .....	555 39	632 72	908 73	538 48	197 42				71 10	381 96	902 97	434 67	4,623 44
Repairs, ordinary .....	16 45	22 65	87 46		84 27	26 44			117 28	136 03	268 97		759 55
do extraordinary .....		324 90			213 60	177 43	189 54	237 60	230 67	587 93	90 32		2,112 09
Totals .....	571 84	980 32	996 19	538 48	495 29	203 92	189 54	237 60	479 05	1,105 92	1,262 26	434 67	7,495 08

Year	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1900	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030

## CLASSIFICATION OF DISBURSEMENTS OF THE DREDGE "CHALLENGE" DURING THE YEAR ENDED 30TH JUNE, 1891.

Items	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Grand totals.
	\$ cts. \$	\$ cts. \$	\$ cts. \$	\$ cts. \$	\$ cts. \$	\$ cts. \$	\$ cts. \$	\$ cts. \$	\$ cts. \$	\$ cts. \$	\$ cts. \$	\$ cts. \$	\$ cts. \$
Wages.....	383 00	333 00	333 00	541 00	30 00	30 00	30 00	30 00	30 00	104 33	239 12	325 50	2,558 95
Coal.....	4 75	236 17	277 80	240 00								770 00	1,588 72
Wood.....				110 40									
Provisions.....	100 00	100 00	100 00										
Stores.....		18 77	11 85		1 25				90 00	107 82	39 35	101 35	551 10
Equipment.....												7 00	305 66
Repairs.....	20 41		96 86		268 94	13 23				108 00	68 97		198 00
Pilottage.....				23 75	5 50				120 63	1,427 38	218 28	65 98	2,231 71
Towage.....												5 00	34 25
Contingencies.....	106 75	19 70	4 40	19 91						18 52	34 47	5 50	208 25
Totals.....	613 91	727 64	823 91	975 06	305 69	43 23	30 00	30 00	240 63	1,946 05	660 19	1,280 33	7,676 64
Working expenses.....	693 50	727 64	727 05	975 06	36 75	30 00	30 00	30 00	120 00	518 67	441 91	1,214 35	5,444 93
Repairs, ordinary.....	20 41		96 86		268 94	13 23			120 63	106 39	218 28	65 98	910 72
do extraordinary.....										1,320 99			1,320 99
Totals.....	613 91	727 64	823 91	975 06	305 69	43 23	30 00	30 00	240 63	1,946 05	660 19	1,280 33	7,676 64

## PUBLIC WORKS

**STATEMENT showing Classification of Cost of Dredging on Ship Channel**

Account	Fuel	Wages	Board	Stores and Materials	General Repairs	General Expenses	Salaries and Office Expenses
Bridge No. 8	1.42	61	5	4	4	4	4
Bridge No. 11	1.42	61	5	4	4	4	4
Bridge No. 12	1.42	61	5	4	4	4	4
Bridge No. 13	1.42	61	5	4	4	4	4
Bridge No. 14	1.42	61	5	4	4	4	4
Bridge No. 15	1.42	61	5	4	4	4	4
Bridge No. 16	1.42	61	5	4	4	4	4
Bridge No. 17	1.42	61	5	4	4	4	4
Bridge No. 18	1.42	61	5	4	4	4	4
Bridge No. 19	1.42	61	5	4	4	4	4
Bridge No. 20	1.42	61	5	4	4	4	4
Bridge No. 21	1.42	61	5	4	4	4	4
Bridge No. 22	1.42	61	5	4	4	4	4
Bridge No. 23	1.42	61	5	4	4	4	4
Bridge No. 24	1.42	61	5	4	4	4	4
Bridge No. 25	1.42	61	5	4	4	4	4
Bridge No. 26	1.42	61	5	4	4	4	4
Bridge No. 27	1.42	61	5	4	4	4	4
Bridge No. 28	1.42	61	5	4	4	4	4
Bridge No. 29	1.42	61	5	4	4	4	4
Bridge No. 30	1.42	61	5	4	4	4	4
Bridge No. 31	1.42	61	5	4	4	4	4
Bridge No. 32	1.42	61	5	4	4	4	4
Bridge No. 33	1.42	61	5	4	4	4	4
Bridge No. 34	1.42	61	5	4	4	4	4
Bridge No. 35	1.42	61	5	4	4	4	4
Bridge No. 36	1.42	61	5	4	4	4	4
Bridge No. 37	1.42	61	5	4	4	4	4
Bridge No. 38	1.42	61	5	4	4	4	4
Bridge No. 39	1.42	61	5	4	4	4	4
Bridge No. 40	1.42	61	5	4	4	4	4
Bridge No. 41	1.42	61	5	4	4	4	4
Bridge No. 42	1.42	61	5	4	4	4	4
Bridge No. 43	1.42	61	5	4	4	4	4
Bridge No. 44	1.42	61	5	4	4	4	4
Bridge No. 45	1.42	61	5	4	4	4	4
Bridge No. 46	1.42	61	5	4	4	4	4
Bridge No. 47	1.42	61	5	4	4	4	4
Bridge No. 48	1.42	61	5	4	4	4	4
Bridge No. 49	1.42	61	5	4	4	4	4
Bridge No. 50	1.42	61	5	4	4	4	4
Bridge No. 51	1.42	61	5	4	4	4	4
Bridge No. 52	1.42	61	5	4	4	4	4
Bridge No. 53	1.42	61	5	4	4	4	4
Bridge No. 54	1.42	61	5	4	4	4	4
Bridge No. 55	1.42	61	5	4	4	4	4
Bridge No. 56	1.42	61	5	4	4	4	4
Bridge No. 57	1.42	61	5	4	4	4	4
Bridge No. 58	1.42	61	5	4	4	4	4
Bridge No. 59	1.42	61	5	4	4	4	4
Bridge No. 60	1.42	61	5	4	4	4	4
Bridge No. 61	1.42	61	5	4	4	4	4
Bridge No. 62	1.42	61	5	4	4	4	4
Bridge No. 63	1.42	61	5	4	4	4	4
Bridge No. 64	1.42	61	5	4	4	4	4
Bridge No. 65	1.42	61	5	4	4	4	4
Bridge No. 66	1.42	61	5	4	4	4	4
Bridge No. 67	1.42	61	5	4	4	4	4
Bridge No. 68	1.42	61	5	4	4	4	4
Bridge No. 69	1.42	61	5	4	4	4	4
Bridge No. 70	1.42	61	5	4	4	4	4
Bridge No. 71	1.42	61	5	4	4	4	4
Bridge No. 72	1.42	61	5	4	4	4	4
Bridge No. 73	1.42	61	5	4	4	4	4
Bridge No. 74	1.42	61	5	4	4	4	4
Bridge No. 75	1.42	61	5	4	4	4	4
Bridge No. 76	1.42	61	5	4	4	4	4
Bridge No. 77	1.42	61	5	4	4	4	4
Bridge No. 78	1.42	61	5	4	4	4	4
Bridge No. 79	1.42	61	5	4	4	4	4
Bridge No. 80	1.42	61	5	4	4	4	4
Bridge No. 81	1.42	61	5	4	4	4	4
Bridge No. 82	1.42	61	5	4	4	4	4
Bridge No. 83	1.42	61	5	4	4	4	4
Bridge No. 84	1.42	61	5	4	4	4	4
Bridge No. 85	1.42	61	5	4	4	4	4
Bridge No. 86	1.42	61	5	4	4	4	4
Bridge No. 87	1.42	61	5	4	4	4	4
Bridge No. 88	1.42	61	5	4	4	4	4
Bridge No. 89	1.42	61	5	4	4	4	4
Bridge No. 90	1.42	61	5	4	4	4	4
Bridge No. 91	1.42	61	5	4	4	4	4
Bridge No. 92	1.42	61	5	4	4	4	4
Bridge No. 93	1.42	61	5	4	4	4	4
Bridge No. 94	1.42	61	5	4	4	4	4
Bridge No. 95	1.42	61	5	4	4	4	4
Bridge No. 96	1.42	61	5	4	4	4	4
Bridge No. 97	1.42	61	5	4	4	4	4
Bridge No. 98	1.42	61	5	4	4	4	4
Bridge No. 99	1.42	61	5	4	4	4	4
Bridge No. 100	1.42	61	5	4	4	4	4

## OF CANADA.

between Montreal and Quebec for the Fiscal Year ended 30th June, 1891.

No. 1 Stone Lifter Service.	Repairs not Charged to Dredging.	Total Cost.	Total Cost including Tug Service.	Number of Working Days.	Cost per Day.	Number of Cubic Yards.	Cost per Cubic Yard.
\$ cts.	\$ cts.	\$ cts.	\$ cts.		\$ cts.		\$ cts.
183 24		8,381 76					
		7,257 45	15,639 21	119	131 42½	40,461	38 65
229 16		17,835 79					
		9,086 78	26,922 57	149	180 68½	60,254	46 68
183 02		8,532 45					
		7,608 64	16,441 09	119	138 16	57,510	28 58
214 55		20,200 04					
		10,672 72	30,872 76	175	176 41½	57,032	54 15
		495 65					
		75 71	571 36	21	27 20		Assisting Dredge at
		7,991 02					Lévis.
		3,171 32	11,162 34	154	72 48½	3,431	3 25
	2,422 75	2,422 75	2,422 75				
	331 20	331 20	331 20				
	463 12	463 12	463 12				
NOV 97	3,217 07	104,826 40	104,826 40				

† Cost per cubic yard greatly increased by work done at Lévis Ferry wharf in 1891.



CLASSIFICATION OF DISBURSEMENTS dredge "Pacific," during the year ended 30th June, 1891.

[1891]

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Items.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Grand totals.
	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.	\$ cts.
Wages	615 00		1,220 00		1,220 00	615 00		655 00	615 00		1,071 32		6,031 32
Coal	360 50				531 44			242 80	266 55				1,401 69
Wood			13 50	8 01				6 65			3 23		13 50
Water	10 34				150 56	122 92	159 84		155 22	162 49	93 25	68 15	28 23
Provisions	68 06	79 80	289 31	81 37	18 05	77 94	31 85		29 80	68 86	17 70	44 25	1,430 97
Stores	44 92	51 34	152 20	24 78					98 47	28 89	12 35	2 50	562 39
Equipment.		82 15		19 63	50 63	12 60	39 36	126 40					472 98
Repairs.													
Pilotage													
Towage.													
Wharfage.													
Contingencies.			11 75		12 00		1 50	7 00				2 50	34 75
Totals	1,069 22	213 29	1,696 76	133 79	1,983 28	828 46	232 55	1,037 85	1,165 04	260 34	1,197 85	117 40	9,975 83
Working expenses	1,069 22	213 29	1,696 76	133 79	1,983 28	828 46	232 55	1,037 85	1,165 04	260 34	1,197 85	117 40	9,975 83
Repairs, ordinary		30 01	35 84	38 48					43 30	56 67	18 00		222 30
do extraordinary	1,039 84	106 20	396 10		100 00	208 00	21 00	47 61				672 58	2,572 33
Totals	2,130 06	349 50	2,118 70	172 27	2,083 28	1,036 46	253 55	1,085 46	1,208 34	317 01	1,215 85	789 98	12,770 46



"ST. LAWRENCE."

Description of Material Dredged.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Grand Totals.
	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.
Hard pan.....	5	240	185		40								470
Boulders.....													
Gravel.....													8,790
Clay.....	5,500	3,200											7,775
Oyster bed.....	700	2,000	2,100	2,975									6,620
Sand, ordinary.....	620	6,000											7,136
do very fine.....			5,775		48								16,540
Mud.....	4,200	2,800	6,475	2,975								1,313	47,331
Totals.....	11,205	14,240	14,535	5,950	88								

"CANADA."

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Grand Totals.
	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.
Hard pan.....													30
Boulders.....			90		90								8,190
Gravel.....	4,410		300	2,070								1,260	6,210
Clay.....													12,570
Clay and stone.....	1,440	900	3,870		600						1,440	4,230	2,370
Sand—ordinary.....	2,520	3,180			2,370						730		720
Sand—very fine.....													30,150
Mud.....													
Totals.....	8,370	4,680	4,320	2,070	3,000						2,160	5,490	



"NIPISSING."									
Sand, very fine Mud.	1,500	8,700	4,020	680					4,200
Totals	5,070	5,700	4,020	680			2,230		21,480
Hard pan.....								615	615
Builders.....	2,168	638						975	3,781
Gravel.....									
Clay.....	1,230	6,367					2,460		10,057
Clay and stone.....	3,105								3,105
Sand, ordinary.....		7,365	8,310	300					15,915
do very fine.....									
Mud.....	937								937
Totals	7,440	7,006	8,310	300			4,050		34,410

**"ST. LOUIS."**

[illegible]

"QUEEN."

[illegible]



CLASSIFICATION and Quantities of Material removed by Dredges, &c.—Continued.

"ONTARIO."

Description of Material Dredged.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Grand Total.
	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.
Boulders.....				1,214	534						443	510	2,701
Gravel.....	650	450	1,085	1,513	533						1,041	930	6,222
Clay.....			7,575	3,748	533						1,041		12,942
Sand, ordinary.....	10,560	9,480	1,500										21,540
Mud.....		650		1,440								1,260	3,360
Totals.....	11,220	10,580	10,170	7,960	1,000						2,525	2,700	46,785

"CHALLENGE."

Hard-pan.....				1,200							1,740	3,900	6,840
Gravel.....			1,860								300		2,160
Clay.....			240	660									900
Clay and stone.....				2,460									2,460
Sand, ordinary.....	11,100	5,220	2,460									3,360	22,140
Mud.....		1,440											1,440
Totals.....	11,100	6,660	4,560	4,320							2,040	7,260	35,940

"PACIFIC."

Sand, ordinary.....						780							2,730
Hard shingle.....									1,440	510			1,630
Mud.....	2,940	3,540	3,360	3,340	2,730	360		1,260	240				17,760
Totals.....	2,940	3,540	3,360	3,340	2,730	1,140		1,260	1,680	2,140			22,130
Working days.....													
Days worked.....													
do repairing.....													
do laid up.....													
Total.....													
284													
284													

### Chart 2.4 - Spending in the Maritime Provinces

## NEW BACKLICK

[illegible]

1. • 38L 75000

2008-2012

Item	Quantity	Unit	Price	Amount
1. 1000	1000	1000	1000	1000
2. 1000	1000	1000	1000	1000
3. 1000	1000	1000	1000	1000
4. 1000	1000	1000	1000	1000
5. 1000	1000	1000	1000	1000
6. 1000	1000	1000	1000	1000
7. 1000	1000	1000	1000	1000
8. 1000	1000	1000	1000	1000
9. 1000	1000	1000	1000	1000
10. 1000	1000	1000	1000	1000
11. 1000	1000	1000	1000	1000
12. 1000	1000	1000	1000	1000
13. 1000	1000	1000	1000	1000
14. 1000	1000	1000	1000	1000
15. 1000	1000	1000	1000	1000
16. 1000	1000	1000	1000	1000
17. 1000	1000	1000	1000	1000
18. 1000	1000	1000	1000	1000
19. 1000	1000	1000	1000	1000
20. 1000	1000	1000	1000	1000
21. 1000	1000	1000	1000	1000
22. 1000	1000	1000	1000	1000
23. 1000	1000	1000	1000	1000
24. 1000	1000	1000	1000	1000
25. 1000	1000	1000	1000	1000
26. 1000	1000	1000	1000	1000
27. 1000	1000	1000	1000	1000
28. 1000	1000	1000	1000	1000
29. 1000	1000	1000	1000	1000
30. 1000	1000	1000	1000	1000
31. 1000	1000	1000	1000	1000
32. 1000	1000	1000	1000	1000
33. 1000	1000	1000	1000	1000
34. 1000	1000	1000	1000	1000
35. 1000	1000	1000	1000	1000
36. 1000	1000	1000	1000	1000
37. 1000	1000	1000	1000	1000
38. 1000	1000	1000	1000	1000
39. 1000	1000	1000	1000	1000
40. 1000	1000	1000	1000	1000
41. 1000	1000	1000	1000	1000
42. 1000	1000	1000	1000	1000
43. 1000	1000	1000	1000	1000
44. 1000	1000	1000	1000	1000
45. 1000	1000	1000	1000	1000
46. 1000	1000	1000	1000	1000
47. 1000	1000	1000	1000	1000
48. 1000	1000	1000	1000	1000
49. 1000	1000	1000	1000	1000
50. 1000	1000	1000	1000	1000
51. 1000	1000	1000	1000	1000
52. 1000	1000	1000	1000	1000
53. 1000	1000	1000	1000	1000
54. 1000	1000	1000	1000	1000
55. 1000	1000	1000	1000	1000
56. 1000	1000	1000	1000	1000
57. 1000	1000	1000	1000	1000
58. 1000	1000	1000	1000	1000
59. 1000	1000	1000	1000	1000
60. 1000	1000	1000	1000	1000
61. 1000	1000	1000	1000	1000
62. 1000	1000	1000	1000	1000
63. 1000	1000	1000	1000	1000
64. 1000	1000	1000	1000	1000
65. 1000	1000	1000	1000	1000
66. 1000	1000	1000	1000	1000
67. 1000	1000	1000	1000	1000

for the Year ended 30th June, 1891.

NOVA SCOTIA.			PRINCE EDWARD ISLAND.			Quantity by each Dredge.	Total Expenditure.
Quantity.	Cost of each Work.	Total Cost.	Quantity.	Cost of each Work.	Total Cost.		
C. yds.	\$ cts.	\$ cts.	C. yds.	\$ cts.	\$ cts.	C. yds.	\$ cts.
						59,325	8,254 04
27,630	10,868 76						
1,800	708 05						
720	283 22	11,860 03				30,150	11,860 03
			17,847	8,305 50			
			1,157	538 42	8,843 92	19,004	8,843 92
9,980	3,246 31						
88	28 62	3,274 93				47,331	15,395 95
3,070	2,183 69						
7,755	3,340 14						
8,655	3,727 78	9,251 61				21,480	9,251 61
61,698	24,386 57	24,386 57	19,004	8,843 92	8,843 92	17,290	53,605 55

## PRINCE EDWARD ISLAND.

Total Quantity.		Expenditure Dredging.	Superinten- dence.	Total. Expenditure.	Cost per Cubic Yard.	
Quantity.	Cost.					
C. yds.	\$ cts.	C. yds.	\$ cts.	\$ cts.	\$ cts.	
		59,325	7,585 29	668 75	8,254 04	0 13 913
		30,150	10,899 11	960 92	11,860 03	0 39 336
19,004	8,843 92	19,004	8,127 35	716 57	8,843 92	0 46 537
		47,331	14,148 53	1,247 42	15,395 95	0 32 528
		21,480	8,502 01	749 60	9,251 61	0 43 070
19,004	8,843 92	177,290	49,262 29	4,343 26	53,605 55	0 30 23

STATEMENT showing the material removed at different localities, the Total Annual Expenditure on each Dredge, and the Average Cost per Cubic Yard, for Fiscal Year, 1890-91.

## DREDGE "WINNIPEG."

Date.	Localities.	Clay.	Totals.
		cu. yds.	cu. yds.
June and July, 1890	West Selkirk, Red River, for Drake & Co.	3,000	
	do do do	3,600	
	do do do for Capt. Robinson	3,060	
	Mouth of Red River, Lake Winnipeg sand and clay	3,180	
	do do	4,080	
			16,920
August, 1890	Mouth of Red River, Lake Winnipeg	3,960	
	do do	4,620	
	Nicholson's channel	3,360	
	do do	3,360	
			15,300
September, 1890	Nicholson's channel	3,960	
	do do	3,600	
	do do	3,360	
	do do	2,880	
			13,800
	Total		45,420

\*\*\*\*\*

Material removed from the mouth of the Red River	1,000	more yards
do do do do do do do do do	1,000	do
do do do do do do do do do	1,000	do
do do do do do do do do do	1,000	do
Total	4,000	do
Material removed from the mouth of the Red River	1,000	more yards
do do do do do do do do do	1,000	do
do do do do do do do do do	1,000	do
do do do do do do do do do	1,000	do
Total	4,000	do

\*\*\*\*\*

Date.	Material.	Clay.	Gravel.	Total.
June and July, 1890	3,000	3,600	3,060	9,660
August, 1890	3,960	4,620	3,360	11,940
September, 1890	3,960	3,600	3,360	10,920
Total	10,920	11,820	9,780	32,520

**DREDGE STATEMENT showing Material removed at different localities, Total Annual Expenditure on each Dredge and Average Cost per cubic yard.**

**DREDGE "CHALLENGE."**

Location.	Hard Pan.	Boulders.	Gravel.	Clay.	Clay and Stone.	Sand, Ordinary.	Sand, Fine.	Mud.	Totals.
Kincardine .....						16,020		1,440	17,460
Port Albert .....			1,860	240		2,760			4,860
Mosford .....	6,840		300	660	2,460				10,260
Owen Sound .....						3,360			3,360
<b>Total</b> .....	<b>6,840</b>		<b>2,160</b>	<b>900</b>	<b>2,460</b>	<b>22,140</b>		<b>1,440</b>	<b>35,940</b>

Total annual expenditure, \$7,676.64. Cost per cubic yard, 21 $\frac{1}{8}$  cents.

**DREDGE "NIPISSING."**

Lachine .....		938			510			937	2,385
Beauharnois .....		1,868		7,597	2,595				12,060
Goose Island .....						15,915			15,915
St. Placide .....	615	975							1,590
Jones' Island .....				2,460					2,460
<b>Total</b> .....	<b>615</b>	<b>3,781</b>		<b>10,057</b>	<b>3,105</b>	<b>15,915</b>		<b>937</b>	<b>34,410</b>

Total annual expenditure, \$7,183.09. Cost per cubic yard, 20 $\frac{3}{8}$  cents.

**DREDGE "ONTARIO."**

Bowmanville .....						780			780
Frenchman's Bay .....			1,110			10,230		660	12,000
Whitby .....						9,930			9,930
Shannonville .....			2,235	10,335		600		660	13,830
Trenton .....		2,701	2,877	2,607				2,040	10,225
<b>Total</b> .....		<b>2,701</b>	<b>6,222</b>	<b>12,942</b>		<b>21,540</b>		<b>3,360</b>	<b>46,765</b>

Total annual expenditure, \$8,527.36. Cost per cubic yard, 18 $\frac{3}{8}$  cents.

**DREDGE "QUEEN."**

Kemptville .....	264	817		394	725			375	2,575
Ottawa River .....						12,372			12,372
Yamaska .....				3,065		384	4,295		7,744
<b>Total</b> .....	<b>264</b>	<b>817</b>		<b>3,459</b>	<b>725</b>	<b>12,756</b>	<b>4,295</b>	<b>375</b>	<b>22,691</b>

Total annual expenditure, \$7,495.08. Cost per cubic yard, 33 $\frac{1}{2}$  cents.

**DREDGE "ST. LOUIS."**

Kemptville .....				2,551		449			3,000
Jones' Island .....						2,800	2,650		5,450
Trenton .....								1,125	1,125
<b>Total</b> .....				<b>2,551</b>		<b>3,249</b>	<b>2,650</b>	<b>1,125</b>	<b>9,575</b>

Total annual expenditure, \$7,153.83. Cost per cubic yard, 74 $\frac{1}{8}$  cents.

Consolidated Sea Products Co. Ltd. (Incorporated in the Straits Settlements)

Particulars	1890		1891		1892		1893		1894		1895		1896		1897		1898		1899		1900		1901		1902		1903		1904		1905		1906		1907		1908		1909		1910		1911		1912		1913		1914		1915		1916		1917		1918		1919		1920		1921		1922		1923		1924		1925		1926		1927		1928		1929		1930		1931		1932		1933		1934		1935		1936		1937		1938		1939		1940		1941		1942		1943		1944		1945		1946		1947		1948		1949		1950		1951		1952		1953		1954		1955		1956		1957		1958		1959		1960		1961		1962		1963		1964		1965		1966		1967		1968		1969		1970		1971		1972		1973		1974		1975		1976		1977		1978		1979		1980		1981		1982		1983		1984		1985		1986		1987		1988		1989		1990		1991		1992		1993		1994		1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		2016		2017		2018		2019		2020		2021		2022		2023		2024		2025		2026		2027		2028		2029		2030		2031		2032		2033		2034		2035		2036		2037		2038		2039		2040		2041		2042		2043		2044		2045		2046		2047		2048		2049		2050		2051		2052		2053		2054		2055		2056		2057		2058		2059		2060		2061		2062		2063		2064		2065		2066		2067		2068		2069		2070		2071		2072		2073		2074		2075		2076		2077		2078		2079		2080		2081		2082		2083		2084		2085		2086		2087		2088		2089		2090		2091		2092		2093		2094		2095		2096		2097		2098		2099		2100		2101		2102		2103		2104		2105		2106		2107		2108		2109		2110		2111		2112		2113		2114		2115		2116		2117		2118		2119		2120		2121		2122		2123		2124		2125		2126		2127		2128		2129		2130		2131		2132		2133		2134		2135		2136		2137		2138		2139		2140		2141		2142		2143		2144		2145		2146		2147		2148		2149		2150		2151		2152		2153		2154		2155		2156		2157		2158		2159		2160		2161		2162		2163		2164		2165		2166		2167		2168		2169		2170		2171		2172		2173		2174		2175		2176		2177		2178		2179		2180		2181		2182		2183		2184		2185		2186		2187		2188		2189		2190		2191		2192		2193		2194		2195		2196		2197		2198		2199		2200		2201		2202		2203		2204		2205		2206		2207		2208		2209		2210		2211		2212		2213		2214		2215		2216		2217		2218		2219		2220		2221		2222		2223		2224		2225		2226		2227		2228		2229		2230		2231		2232		2233		2234		2235		2236		2237		2238		2239		2240		2241		2242		2243		2244		2245		2246		2247		2248		2249		2250		2251		2252		2253		2254		2255		2256		2257		2258		2259		2260		2261		2262		2263		2264		2265		2266		2267		2268		2269		2270		2271		2272		2273		2274		2275		2276		2277		2278		2279		2280		2281		2282		2283		2284		2285		2286		2287		2288		2289		2290		2291		2292		2293		2294		2295		2296		2297		2298		2299		2300		2301		2302		2303		2304		2305		2306		2307		2308		2309		2310		2311		2312		2313		2314		2315		2316		2317		2318		2319		2320		2321		2322		2323		2324		2325		2326		2327		2328		2329		2330		2331		2332		2333		2334		2335		2336		2337		2338		2339		2340		2341	
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Inverness	Halifax Railway Terminus	10,290	6,187 38			10,290	6,187 38
	Jeddore	21,515	4,868 56			21,515	4,868 56
	North-West Arm	7,850	2,970 80			7,850	2,970 80
	Cunard's Wharf	1,400	530 04	29,106 91		1,400	530 04
							29,106 91
Whycconagh	Whycconagh	10,760	3,491 31			10,760	3,491 31
	Campbell's Pond	4,940	872 83			4,940	872 83
	Port Hastings	270	190 37			270	190 37
	Cheticamp	113,445	34,622 87	8,655	3,727 78	122,100	38,350 65
	Malou	72,987	31,110 10	27,630	10,808 76	100,597	41,978 86
Lunenburg	Port Hood	2,800	855 44	71,142 92	14,506 54	2,800	855 44
							85,739 46
	Lunenburg	70,510	22,194 57			70,510	22,194 57
	Mahone Bay	21,844	5,958 65			21,844	5,958 65
	Vogler's Cove	11,610	5,075 53	33,228 75		11,610	5,075 53
Pictou							33,228 75
	Acadia Coal Co. Wharf	10,240	3,560 26			10,240	3,560 26
	Albion Mines	9,475	2,181 25			9,475	2,181 25
	East River	104,795	25,067 22			104,795	25,067 22
	Halifax Coal Co. Wharf	1,650	359 90			1,650	359 90
Pictou Public Wharf	Pictou Public Wharf	7,020	1,634 82			7,020	1,634 82
	do Market Wharf	16,573 19	9,959 34	11,740	3,954 36	73,930	20,527 55
	do Railway Wharf	32,164	7,345			32,164	7,345
	do Landing	1,395	682 15			1,395	682 15
	Vale Colliery Wharf	85,173	22,243 98			85,173	22,243 98
Queen's	River John	25,110	10,707 59			25,110	10,707 59
	Granton	26,310	5,705 09			26,310	5,705 09
	New Glasgow	7,000	2,138 60			7,000	2,138 60
	Middle River			103,693 40			
	Dwyer's Wharf			720	283 22	720	283 22
Richmond	Liverpool	12,940	4,762 38			12,940	4,762 38
	D'Escoisse	11,860	5,962 13			11,860	5,962 13
	St. Peter's Canal	79,161	24,434 52			79,161	24,434 52
	St. Peter's	7,150	2,407 41			7,150	2,407 41
	Grand Goulet	23,584	5,570 49			23,584	5,570 49
Shelburne	River Bourgeois	18,920	4,468 87			18,920	4,468 87
	Marine Ship	320	56 53			320	56 53
	Lockeport	34,048	10,591 41			34,048	10,591 41
	Barrington	20,205	7,658 50			20,205	7,658 50
	Yarmouth	105,524	38,951 26			105,524	38,951 26
Dredge "C. B. "	Hants	5,450	1,627 60			5,450	1,627 60
	Windsor	3,820	1,569 95			3,820	1,569 95
	Aspen Bay						
Total		1,540,549	495,709 41	61,698	24,386 57	1,608,247	520,095 98



York	Frederickton	30,385	7,000 15			30,385	7,000 15
	St. Mary's Ferry	15,570	6,827 36			15,570	6,827 36
	Gileau	30,385	4,379 52			30,385	4,379 52
				18,006 03			18,006 03
King's	Belleisle Point.	60,170	8,156 76			60,170	8,156 76
	Hampton	4,750	1,200 25			4,750	1,200 25
	Ferry's Point	11,000	1,926 50			11,000	1,926 50
	Lamb's do			11,283 51			
					9,890		1,305 08
					27,020		3,759 31
					22,925		3,189 65
					96,598		20,375 06
Total		1,315,169	311,191 37	311,191 57	20,375 06	1,411,757	331,566 63
							331,566 63

## EXPENDITURE for Dredging in Prince Edward Island

		Total for the Eighteen Years ended 30th June, 1890.		
District.	Locality.	Quantity.	Cost.	Cost for County.
		C. Yds.	\$ cts.	\$ cts.
B. & C.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
A. & B.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
C. & D.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
D. & E.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
E. & F.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
F. & G.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
G. & H.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
H. & I.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
I. & J.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
J. & K.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
K. & L.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
L. & M.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
M. & N.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
N. & O.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
O. & P.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
P. & Q.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
Q. & R.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
R. & S.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
S. & T.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
T. & U.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
U. & V.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
V. & W.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
W. & X.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
X. & Y.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
Y. & Z.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....

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		Quantity.	Cost.	Cost for County.
A. & B.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
C. & D.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
E. & F.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
G. & H.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
I. & J.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
K. & L.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
M. & N.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
O. & P.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
Q. & R.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
S. & T.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
U. & V.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
W. & X.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....
Y. & Z.	Pointe à la Peste	1,200	12.00	.....
	Pointe à la Peste	1,200	12.00	.....

for the Nineteen years ended 30th June, 1891.

For the Year 1890-91.			Total Quantity.	Total Cost.	Cost for each County.
Quantity.	Cost.	Cost for County.			
C. Yds.	\$ cts.	\$ cts.	C. Yds.	\$ cts.	\$ cts.
			46,110	8,963 97	
			106,140	17,119 43	
			44,430	7,378 33	33,461 73
			41,303	10,264 56	
			4,045	670 61	
			89,782	27,493 03	
			44,400	9,604 55	
			91,440	14,661 16	
			17,860	6,326 72	
			2,780	548 00	
			31,650	6,286 46	
			750	150 51	
			12,165	2,441 28	
			3,825	756 24	
			3,195	631 68	
			33,015	5,528 75	
			7,161	3,879 60	
			7,668	4,904 15	
			5,343	3,417 17	
			5,355	3,424 85	
			4,950	2,077 52	
			13,536	4,775 38	
			11,649	4,109 67	
17,847	8,305 50	8,305 50	17,847	8,305 50	120,257 39
			15,855	2,495 34	
			41,070	7,289 95	
			11,387	13,006 45	
1,157	538 42	538 42	1,157	538 42	23,329 16
19,004	8,843 92	8,843 92	715,868	177,048 28	177,048 28

ended 30th June, 1891, from Appropriations—Maritime Provinces.

	6,800	2,392 29	
	495	242 05	2,634 97
	2,587	825 47	825 47
	8,123	3,997 59	3,997 59
	18,005	7,458 03	7,458 03



STATEMENT of Dredging, showing Quantities Removed by hand in each Province and cost of each Dredging, for the Nineteen years ended 30th June, 1891.

Fiscal Year.	NEW BRUNSWICK.		NOVA SCOTIA.		QUEBEC.		PRINCE EDWARD ISLAND.		Total Quantity.	Total Expenditure.	Cost per cubic yard.
	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.			
	c. yds.	\$ cts.	c. yds.	\$ cts.	c. yds.	\$ cts.	c. yds.	\$ cts.			
1878 79			245	555 13					245	555 13	2 28 58
1879 80			12,370	3,666 90					12,370	3,666 90	0 29 64
1880 81			11,140	2,660 25					11,140	2,660 25	0 22 98
1881 82			10,640	2,650 00					10,640	2,650 00	0 24 90
1882 83			8,190	2,500 00					8,190	2,500 00	0 30 52
1883 84			5,460	2,500 00					5,460	2,500 00	0 45 78
1884 85											
1885 86											
1886 87											
1887 88											
1888 89											
1889 90											
1890 91											
Totals			48,045	14,432 28					48,405	14,432 28	2 30 03



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**APPENDIX No. 4.**

**LIST**

**OF**

**ENGINEERS, ENGINEMEN, FIREMEN AND CARETAKERS**

**OF**

**PUBLIC BUILDINGS THROUGHOUT THE DOMINION,**

**GIVING**

**Date of Appointment, Salary Paid, &c.**

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St. Stephen	do	Stannard Tapping	April	2, 1889	do	May	25, 1887	35 33	12	do	400 00
St. John	do	Thomas Ashill	Feb.	18, 1880	do	Oct.	19, 1885	33 33	12	do	400 00
do	Custom House	G. H. Jones	June	2, 1885	Engineer	Feb.	17, 1880	30 00	12	do	720 00
do	do	Christopher White	Nov.	20, 1844	Fireman	Nov.	9, 1885	50 00	6	do	300 00
do	Post Office	T. W. Shaw	Sept.	2, 1844	Caretaker	Dec.	8, 1881	41 07	12	do	500 00
do	do	Henry Howe	May	1, 1853	Engineer	Nov.	4, 1881	55 00	12	do	600 00
do	do	Ed. Hauey	Feb.	22, 1849	Host attendant	do	27, 1882	50 00	12	do	600 00
do	Pentitentiary	Geo. Campbell	do	22, 1817	Caretaker	Oct.	29, 1880	37 50	12	do	450 00
Wenduck	Post Office	Wm. Kennedy	May	2, 1825	do	Feb.	1, 1890	33 33	12	do	400 00
Aylmer	do	J. R. Woods	Mar.	18, 1817	do	Nov.	8, 1889	33 33	12	do	100 00
Caticus	Public Building	Israel Baldwin	Nov.	16, 1839	do	June	27, 1889	33 33	12	do	400 00
Hull	Post Office, &c	Thomas Paquin	Sept.	2, 1866	do	Jan.	9, 1888	16 66	12	do	200 00
Joliette	do	Chas. Guilbault	do	20, 1828	do	Oct.	15, 1888	33 33	12	do	400 00
Montreal	Dominion Buildings	Thos. Ryan	June	18, 1836	Foreman engineer	Mar.	4, 1882	100 00	12	do	1,200 00
do	Examining Warehouse	M. Boyer	Feb.	18, 1844	Fireman	do	4, 1882	50 00	12	do	600 00
do	do	D. St. George	Oct.	8, 1844	do	Oct.	1, 1890	45 00	12	do	540 00
do	Post Office	John Watson	Feb.	21, 1820	Engineer	do	18, 1876	65 00	12	do	780 00
Montreal	do	L. D. Thibault	do	do	Electric light and host attendant	June	1, 1885	60 00	12	do	720 00
do	Inland Revenue	F. Greene	Oct.	4, 1887	Engineer	Jan.	1, 1885	60 00	12	do	720 00
do	Custom House	W. Wallace	Augt.	12, 1837	Fireman	Oct.	1, 1882	50 00	8	do	400 00
do	do	J. H. Marchand	Sept.	6, 1849	do	Dec.	2, 1882	50 00	8	do	400 00
Quebec	Drill Hall and Armories	Wm. McDonald	Sept.	17, 1832	Engineer	Feb.	21, 1888	45 00	12	do	540 00
do	Examining Warehouse	Jas. Matthews	Sept.	25, 1836	Engineer	Dec.	4, 1885	55 00	12	do	690 00
do	do	Wm. Stephens	do	do	Fireman	Oct.	29, 1886	40 00	8	do	320 00
do	Culler's Office	John O'Neil	June	23, 1819	do	Sept.	8, 1886	45 00	8	do	360 00
do	Custom House	Thos. Rawson	Nov.	1, 1848	Acting Fireman	Nov.	10, 1888	45 00	12	do	540 00
Sorel	Post Office	P. St. Michel	May	20, 1841	Caretaker	Dec.	12, 1884	33 33	12	do	400 00
do	do	Widow J. Forrant	Feb.	26, 1829	do	Sept.	22, 1886	33 33	12	do	400 00
do	do	Wm. Comper	Oct.	27, 1814	do	May	30, 1888	16 66	12	do	200 00
St. John's	Public Building	Medard Guignon	May	20, 1826	Watchman	Dec.	28, 1881	12 50	12	do	150 00
St. Jerome	Custom House	Ph. Gravel	June	25, 1828	Caretaker	March	11, 1890	33 33	12	do	400 00
Three Rivers	do	Jo. Carbonneau	June	3, 1828	do	Feb.	1, 1891	25 00	12	do	300 00
do	Post Office	Geo. McLeod	June	24, 1828	do	July	27, 1883	33 33	12	do	400 00
do	Custom House	John Lovegrove	April	16, 1838	Messenger	Feb.	1, 1891	25 00	12	do	300 00
Amherstburg	Post Office	Wm. Moulton	Dec.	19, 1838	Caretaker	Nov.	5, 1885	33 33	12	do	400 00
do	do	Wm. Shephard	March	23, 1839	do	Jan.	30, 1891	33 33	12	do	400 00
Almonte	do	John Squires	June	13, 1831	do	April	6, 1888	33 33	12	do	400 00
Brantford	do	Fred. Edwards	April	24, 1842	do	Oct.	27, 1880	50 00	12	do	600 00
Barrie	do	J. P. Reeves	March	3, 1844	do	March	2, 1886	33 33	12	do	400 00
Belleville	do	Widow Aug. Meinko	Nov.	27, 1829	do	Oct.	17, 1883	50 00	12	do	600 00
Berlin	do	James McBride	Nov.	23, 1844	do	Dec.	22, 1887	33 33	12	do	400 00
Brampton	do	Gilbert Campbell	Oct.	5, 1840	do	Jan.	25, 1891	33 33	12	do	400 00
Clifton	do	Henry Dunn	Feb.	11, 1849	do	Oct.	8, 1885	33 33	12	do	400 00
Chatham	do	Wm. W. Mitchell	May	25, 1841	Engineer	Sept.	23, 1884	50 00	7	do	350 00
do	do	Thos. Murphy	May	1, 1843	Caretaker	Jan.	7, 1885	33 33	12	do	400 00
Cornwall	do	H. J. Payne	May	29, 1826	do	March	26, 1890	4 16	12	do	50 00
Cayuga	do	do	Jan.	31, 1854	do	April	24, 1890	33 33	12	do	400 00

\*Resigned Mar. 27, 1891.

TABLE showing the Engineers, Engineemen, Firemen, Carpenters, Hoist Attendants and Watchman employed at Dominion Public Buildings etc., Continued.

Place.	Building.	Name.	Date of Birth.	Position.	Date of Appointment.	Salary per Month.	Time Employed per Annum.	Total Salary per Annum.
						\$ cts.		\$ cts.
Que. Post Office		Wm. Kilgorn	March 3, 1857	Carpenter.	Sept. 25, 1886	33 33	12 months	400 00
" do		Robert Higham	May 26, 1834	do	Oct. 26, 1886	33 33	12 do	400 00
" do		Thos. P. Richardson	Feb. 26, 1834	do	May 1, 1886	33 33	12 do	400 00
" do		Le wis Jellard	April 8, 1832	do	July 2, 1886	33 33	12 do	400 00
" do	Domestic Building	Wm. Healey	Nov. 14, 1829	do	Oct. 9, 1886	50 00	12 do	600 00
" do		Thos. Beatty	Nov. 14, 1848	Fireman	Nov. 7, 1887	45 00	12 do	540 00
" do		Thos. Nicholson	Dec. 17, 1827	Engineer	March 2, 1887	50 00	12 do	600 00
" do	David Hall	Wm. Hume	May 26, 1844	Fireman	Dec. 12, 1886	45 00	12 do	540 00
" do	St. Mary College	William Johnson	Sept. 12, 1842	Engineer	May 31, 1881	65 00	12 do	780 00
" do		M. Mulhern	Jan. 22, 1838	Fireman	Oct. 11, 1878	50 00	6 do	300 00
" do	Custom House	M. Mulhern	Sept. 4, 1837	Engineer	Sept. 18, 1886	50 00	12 do	600 00
" do	Post Office	John Fox	Oct. 12, 1830	Carpenter	March 16, 1884	33 33	12 do	400 00
" do	Post Office & C. House	William Mc Mann	May 27, 1831	Carpenter	Jan. 14, 1884	50 00	12 do	600 00
" do	do	John Healey	March 26, 1853	do	March 15, 1880	33 33	12 do	400 00
" do	Post Office	John Wilkins	May 26, 1830	do	Sept. 15, 1880	33 33	12 do	400 00
" do	do	John Twinn	May 17, 1842	do	Sept. 8, 1887	33 33	12 do	400 00
" do	do	Wm. Armstrong	Sept. 6, 1846	do	June 11, 1886	20 00	12 do	240 00
" do	do	Le wis Hebble	Feb. 16, 1830	do	Nov. 17, 1885	33 33	12 do	400 00
" do	Public Building	Samuel Hamilton	June 14, 1834	do	Oct. 20, 1880	33 33	12 do	400 00
" do	Post Office and C. House	Edna Hamilton	April 6, 1822	do	Dec. 23, 1880	33 33	12 do	400 00
" do	do	J. H. Roberts	May 1, 1847	Engineer	Feb. 7, 1884	50 00	12 do	600 00
" do	do	Wm. Bryant	Feb. 6, 1832	Carpenter	Aug. 9, 1883	33 33	12 do	400 00
" do	do	Wm. Russell	Sept. 15, 1832	do	Sept. 4, 1885	33 33	12 do	400 00
" do	do	Wm. Russell	May 19, 1840	do	Oct. 25, 1880	33 33	12 do	400 00
" do	Public Building	J. A. Willis	Aug. 6, 1845	Fireman	Aug. 28, 1873	125 00	12 do	1,500 00
" do	Domestic Building	Chas. F. Badger	Sept. 22, 1852	Fireman	Jan. 13, 1881	50 00	6 do	300 00
" do	Indian Revenue Building	Frederick Fargher	Oct. 16, 1845	do	Nov. 1, 1880	50 00	12 do	600 00
" do	Custom House	Chas. Campbell	Feb. 20, 1844	Engineer	Dec. 28, 1874	55 00	12 do	780 00
" do	Examining Warehouse	Ed. Appleton	Sept. 25, 1840	Fireman	Sept. 28, 1880	55 00	12 do	660 00
" do	do	Alas. Jay	do	do	Sept. 1, 1887	50 00	12 do	600 00
" do	do	Wm. Chinery	Dec. 10, 1851	do	do	50 00	12 do	600 00
" do	do	W. J. Sloan	July 6, 1855	do	do	50 00	12 do	600 00
" do	do	Chas. Richardson	Feb. 23, 1831	Watchman	Mar. 2, 1888	46 50	12 do	558 00
" do	do	Henry L. Bell	Dec. 20, 1844	Engineer	Sept. 9, 1885	50 00	6 do	300 00





**APPENDIX No. 5.**

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**REPORT**

**ON THE**

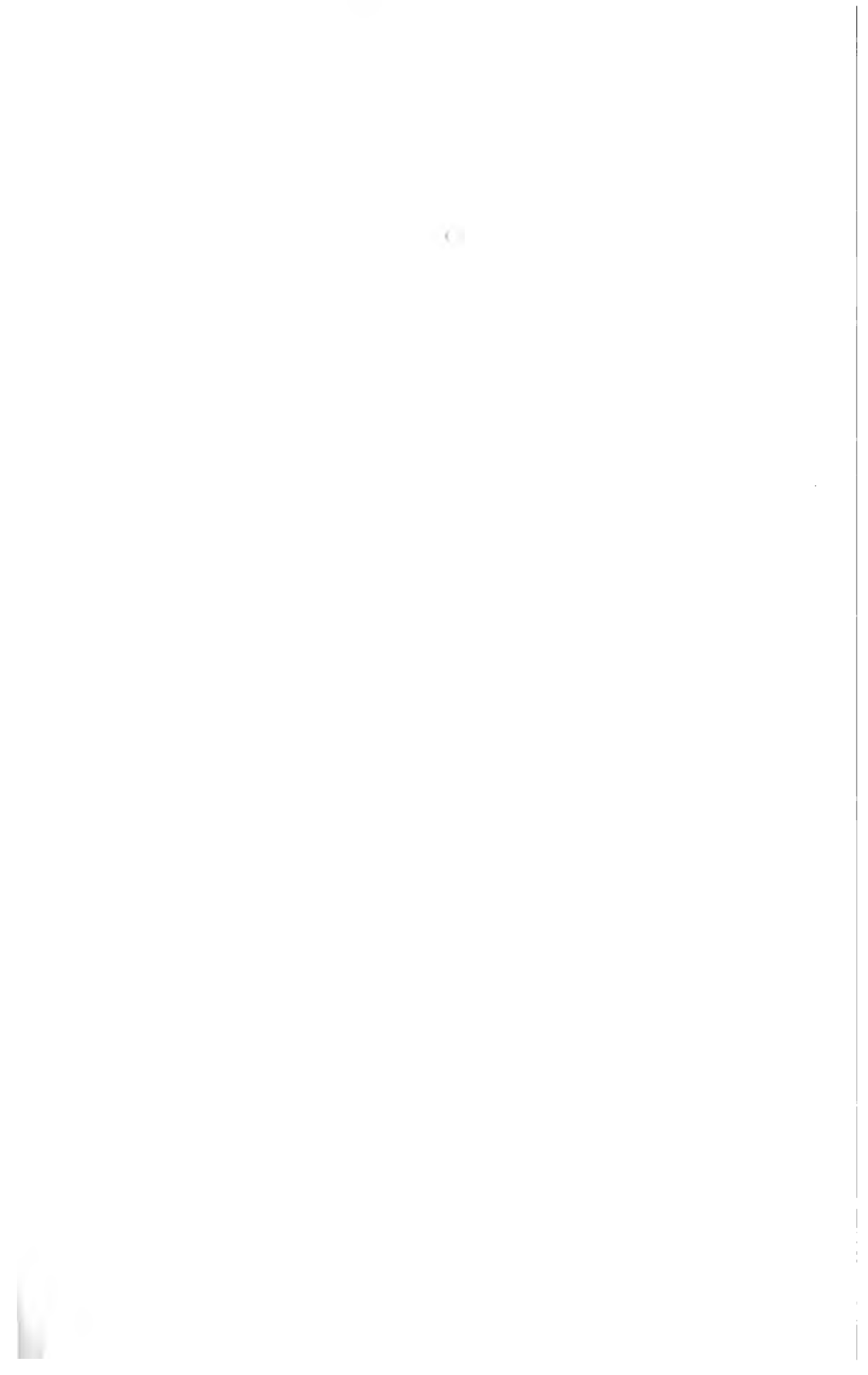
**HEATING APPARATUS, GAS, WATER AND BELL SERVICES, &c.**

**IN THE**

**PUBLIC BUILDINGS, OTTAWA,**

**FOR THE FISCAL YEAR ENDED 30<sup>TH</sup> JUNE, 1891.**

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## APPENDIX No. 5.

DEPARTMENT OF PUBLIC WORKS,  
MECHANICAL ENGINEER'S OFFICE,  
OTTAWA, 14th October, 1891.

SIR,—I have the honour to report as follows in reference to the Public Buildings, Ottawa, during the fiscal year ended the 30th June, 1891:—

### PARLIAMENT BUILDINGS.

In the House of Commons the electric light was extended to the rooms occupied by the Clerk of Votes and Proceedings.

The old pan w. c.'s in connection with the Commons and Library having been so long in use were in a very unsatisfactory state, and it was found necessary to replace them with those of a more modern pattern, which has much improved the sanitary condition of the building.

To moderate the temperature of the Commons Chamber during the present session quantities of ice were introduced into the fresh air duct during the month of June, which had the desired effect of cooling the air admitted to the Chamber.

Beyond the above improvements ordinary maintenance only was required to the general apparatus of heating, boilers, gas, water, bells, electric light and ventilation services during the fiscal year.

### EAST AND WEST BLOCKS.

The old style w. c.'s in these buildings were replaced with more modern appliances. Nothing was required to be done to the heating apparatus, boilers, water, gas and bell service beyond ordinary maintenance.

### SUPREME COURT.

Beyond the ordinary maintenance, nothing was required to be done in this building.

### OTTAWA POST OFFICE AND CUSTOM HOUSE.

It was found necessary to replace the old pan w. c.'s in this building with those of a more modern pattern.

Nothing further was required except ordinary maintenance to the general apparatus of heating, boiler, gas, water and bell services.

### GEOLOGICAL MUSEUM.

The old style pan w. c.'s in this building were replaced with those of a more modern pattern.

Beyond this there was nothing but ordinary maintenance required to the heating apparatus, water, gas and bell services.

### FISH HATCHERY.

Nothing was required in this building beyond ordinary maintenance.

### RIDEAU HALL.

Ordinary maintenance only was required to the general apparatus for heating, water, gas and electric bells.

## GOVERNMENT PRINTING BUREAU.

With the exception of a ventilating pipe that was placed from the gas metre room in the basement and ran up through the roof, nothing was required beyond ordinary maintenance to the heating apparatus, gas, water and electric bell services.

## INTERIOR DEPARTMENT (LEASED) WELLINGTON STREET.

Ordinary maintenance only was required for the water, gas and bell services in this building.

## FRENCH TRANSLATOR'S ROOMS (LEASED) SUSSEX STREET.

These premises were fitted up with stoves, water and gas fixtures.

## PARLIAMENT GROUNDS, FLOWER PROPAGATING HOUSE AND MAJOR HILL PARK.

No alterations or extensions have been made during the year to these premises. ordinary maintenance only was required to the heating apparatus and hose required for sprinkling purposes to any of the three foregoing.

## GOVERNMENT COAL SHEDS.

With the exception of a new floor put in the central part of large shed, no other work was required beyond ordinary repairs to these buildings.

I have the honour to be, Sir,

Your obedient servant,

WM. KING,

*Acting Chief Mechanical Engineer.*

E. F. E. Box, Esq.,  
Secretary Dept. Public Works.

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APPENDIX No. 6.

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REPORT

ON THE

OTTAWA DISTRICT SLIDES AND BOOMS

FOR THE

FISCAL YEAR ENDED 30TH JUNE, 1891.

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## APPENDIX No. 6.

### OTTAWA RIVER WORKS.

No. 36662.

DEPARTMENT OF PUBLIC WORKS OF CANADA,  
CHIEF ENGINEER'S OFFICE,  
OTTAWA, 27th October, 1891.

SIR,—I transmit herewith a report by Mr. G. P. Brophy, Superintending Engineer of the Ottawa District Works, on the works under his charge, for the fiscal year ended 30th June, 1891.

I have the honour to be, Sir,  
Your obedient servant,  
LOUIS COSTE,  
*Acting Chief Engineer.*

E. F. E. ROY, Esq.,  
Secretary, Department of Public Works,  
Ottawa.

OFFICE OTTAWA RIVER WORKS, 1st August, 1891.

SIR,—As requested by you in your letter, No. 35483, of the 10th instant, I have the honour to submit the following report on the works under my charge, for the fiscal year ended 30th June last:—

During the latter portion of the season of navigation, 1890, the waters of the Ottawa and tributary rivers fell to a low pitch, but most of the timber which had passed the upper works reached its destination. The foundations of the various structures were examined at the lowest water period during the autumn months, and preparations were made for the commencement of the necessary works of repair and reconstruction, as follows:—

#### REPAIRS AT STATIONS ON THE MAIN STREAM OR OTTAWA RIVER.

*At Carillon Station.*—The guide boom at the head of slide was strengthened by placing support timbers fastened with screw bolts alongside the weaker portions, and the mooring and snubbing appliances improved. The boom planking was also overhauled and additional chains provided.

*Ottawa or South Chaudière Station.*—The side piers of the lower slide were repaired by the insertion of new timbers and the removal and refilling of stone in the cribwork and the sheeting of the slides made good where defective; iron plates were placed on the more exposed portions of the slide entrances; the platforms and superstructures of bulkheads repaired; the stop logs and apron timbers overhauled, and the station buildings extended and repaired, where necessary.

*Hull or North Chaudière Station.*—The slide planking at this station was patched and the boom fastenings and timbers strengthened.

*Bridges.*—The line of iron bridges over the slide and hydraulic channels at Chaudière in the city of Ottawa had the planking of the roadway extensively repaired and the tension rods and braces of the superstructure adjusted. The Union bridge roadway planking was also repaired and certain portions of the iron-

work which had been damaged by passing teams made good. The wooden bridge over the Hull slide had its planking and sidewalks kept up, and the causeway or thoroughfare between the latter structure and the Union bridge was graded up and macadamized.

*The Dufferin and Sappers' Bridges*, over the Rideau Canal, were repaired in their roadway coverings, iron works and footpaths; while the

*Maria Street Bridge*, spanning the same waterway, was thoroughly overhauled, strengthened and repaired from foundation to superstructure, by the insertion of new timbers and the placing of additional support braces, iron bolts, plates and straps.

*Chats' Station*.—At this place the side piers of the slide, the bottom planking, guide booms and support piers were repaired and improvements made in the bulkhead equipment.

*Chenau Station*.—The strength of the current here necessitated additional supports for the main boom, consequently three anchor piers had to be built, together with a float and boat house for the accommodation of the men operating the trip for the passage of steamboat towing rafts. Certain other minor repairs were also executed on the boom chains, moorings and attachments.

*Portage du Fort Station*.—The main guide booms at the head of the slide had become useless through the decay of their timbers and had to be replaced, the top courses of timber on the side piers of the slide having also given out from the same cause, new ones were substituted, and the plank covering of the dams in the side channels stanchied and repaired.

*Mountain Station*.—New hardwood stop logs were provided for the regulating bulkhead, the guide booms repaired and the slide planking, &c., renewed where worn out or displaced.

*Rocher Capitaine Station*.—At this place the slide bulkhead, dam, piers and booms were repaired. At the entrance bulkhead where the corners of the piers had been very much damaged by the battering of cribs making for the head of the slide, steel plates were spiked on the exposed portions of the work.

#### REPAIRS OF WORKS ON TRIBUTARIES OF THE OTTAWA.

*Gatineau River*.—At the main boom near the mouth of the stream sunken piers were placed with the view of furnishing additional sorting facilities in passing logs out through the gaps; the bridges over the canals having become dilapidated through the decay of their timbers, they with their abutment piers were for the most part rebuilt, and large quantity of bark, slabs and other description of mill rubbish, which had been deposited in the outlet creek from the pond, was removed at the season of low water, and soundings were taken to indicate the position of sand bars obstructing the navigation in the vicinity of the main boom and having a tendency to change the direction of the current of the Gatineau River to the extent of its undermining the banks and encroaching in the roadways and thoroughfares necessary for the important works at this station.

*Madawaska River*.—The ice in passing out during the spring floods of 1890, carried away a pier at Little Rapids; this had to be replaced, and some other repairs done in connection with the booms and the dam at head of rapid. The slide, piers and booms at Arnprior were repaired in their timbers and stone filling, and the dams, piers and booms at Flat Rapids and Goodfellow's Eddy were overhauled and the damages caused by the shoving ice and high water made good; repairs were also carried out, where necessary, at Springtown and Ragged Chute Stations.

*Coulange River*.—On this stream on the 20th of April last a portion of the long slide which overcomes the High Falls, was smashed by the fall of a large piece of rock from the mountain side flanking the works. The necessary repairs were made to the bents, cribwork and planking; and steps taken to guard against a recurrence by the gradual removal of loose stones that might have caused damage to the works later on.

*Black River.*—The planking of the slide which had become worn or displaced by the friction of the passing logs and timber was renewed and the seams caulked. The side pier timbers were levelled up and the boom timbers and braces strengthened.

*Petewawa River.*—The improvements on this important tributary have been many years in existence, and the timber work is very much decayed. A thorough reconstruction of the greater number of the dams, slides, piers, booms, &c., on this stream will have to take place immediately, as many of the structures are beyond repairing. In order that the works could be made available for the business of 1891, repairs were made from the Cedar Lake dam down to the Boisdur station. The work done being chiefly repairs to the timber and planking of the dams, piers and single stick slides, and the strengthening of the main retaining dam at Cedar Lake.

*Dumoine River.*—The repairs executed on this stream were in connection with the damage caused by high water at Ryan's Chute dams, and also at the long single-stick slide and entrance and outlet piers at High Falls.

#### WORK OF RECONSTRUCTION.

At the Calumet Station, on the Ottawa River, the lower bulkhead of the upper slide was built anew; cribwork repaired at the entrance, and the side piers rebuilt in part.

The waste gate at basin between first and second slides was renewed and made of greater width than the old one, and rocks obstructing the channel removed. At the second or long slide the piers on both sides were renewed from the foundations upwards; maple plank laid as flooring for the slide; a new apron provided and the long pier dam which retains the water forming the basin between the second and third slides wholly rebuilt. The third or lower slide had the side piers and bulkhead reconstructed and the boulders removed from the outlet.

*Joachim Station on the Ottawa.*—The main dam on the south side of the river was made secure and the plank covering renewed in part; additional chains were furnished for the booms and their fastening and moorings strengthened.

On the Petewawa River the slide at Crooked Chute was rebuilt in its principal parts, and the single stick slide at McDonald's Chute overhauled, where the foundation timbers, side posts and planking had become dilapidated.

At the lower stations, viz., first, second and third chutes, the decayed timbers in sills and posts, as well as the defective planking in the single stick slides were renewed and new material substituted.

Notwithstanding the severity of last winter with its great snowfall in the woods and the formation of very heavy ice on the lakes and streams, the spring freshets did comparatively little damage to the works on the tributaries where many of the improvements have been in use for upwards of twenty-five and in some cases thirty years, and cannot by any means short of reconstruction, be made serviceable for the passage of timber.

High water in the early spring was followed by a protracted period of drought, which had the effect of bringing the waters of the creeks and rivers to a lower pitch than the raftsmen have experienced on the drives for many years.

The logs and timber which were got under way at the breaking up in the spring were later in the season kept moving through the works and over the lower shoals, mainly by flushing with the reserved waters from the retaining dams or reservoirs on the upper reaches of the streams, and in consequence the works were subjected to great strain and wear and tear.

The following statement furnished by the collector of slides dues in your department, shows the quantities of the various descriptions of timber that passed the works, together with the amount of revenue accrued as tolls for the fiscal year covered by this report:—

	Pieces.
White pine timber.....	119,339
Red do .....	2,365
Boom and dimension timber flat.....	15,629
Spruce and tamarack (round).....	854
Dimension timber, .....	34,898
Cedars.....	9,984
Pence posts.....	200
Square traverses.....	48
Railroad ties .....	46,707
Sawlogs.....	2,900,290
	<hr/>
	3,130,314

and 1,732½ cords pulpwood.

The revenue accrued on the above was \$73,188.06.

In respectfully submitting the above,

I have the honour to be, Sir,

Your obedient servant,

GEO. P. BROPHY,

*Superintendent of Foreman of Ottawa River Works.*

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APPENDIX No. 7.

REPORT

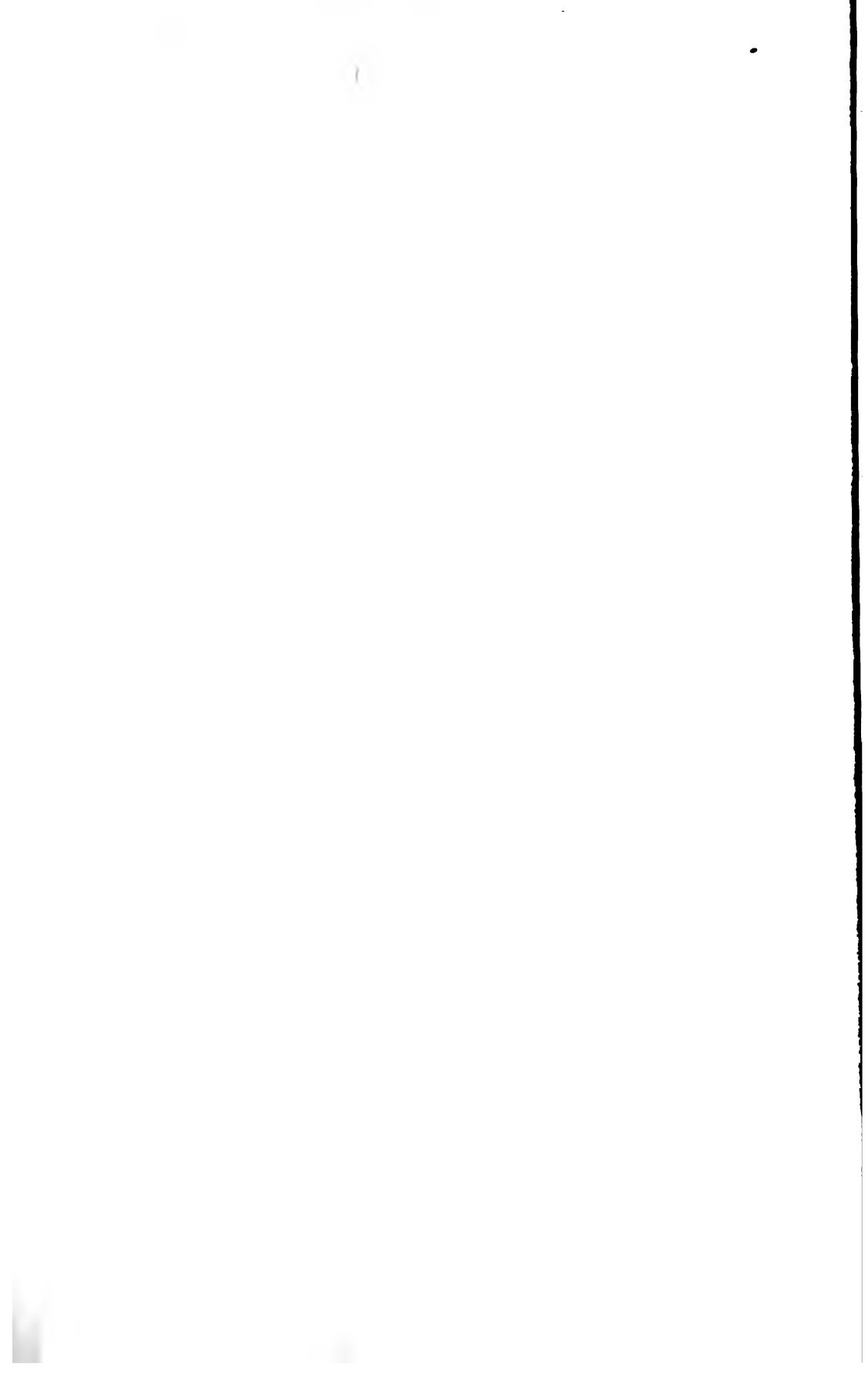
ON THE

NEWCASTLE DISTRICT SLIDES AND BOOMS

FOR THE

Fiscal Year ended 30th June, 1891.

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## APPENDIX No. 7.

### NEWCASTLE DISTRICT SLIDES AND BOOMS.

Ref. No. 36661.

DEPARTMENT OF PUBLIC WORKS,  
CHIEF ENGINEER'S OFFICE, OTTAWA, 27th October, 1891.

SIR,—I transmit herewith a report by Mr. R. B. Rogers, Superintending Engineer of the Trent and Newcastle District works, on the works under his charge for the fiscal year ended 30th June, 1891.

I have the honour to be, Sir,

Your obedient servant,

LOUIS COSTE,  
*Acting Chief Engineer.*

E. F. E. ROY, Esq.,  
Secretary, Department of Public Works,  
Ottawa.

TRENT VALLEY CANAL,  
SUPERINTENDING ENGINEER'S OFFICE, PETERBORO', 28th July, 1891.

SIR,—I have the honour to submit the annual report on the works under my charge in connection with the Department of Public Works for the fiscal year ended 30th June, 1891.

The water during the spring was much above the average, in fact higher on some stretches than it has been since the flood of 1870. The ice also came down in a much more solid condition than usual, and did more or little damage at every station on the works. However no serious damage was done at any station.

The following repairs were executed:—

#### FENELON FALLS.

About 50 feet of the cap of the dam was taken out, and part of the apron of the slide. These were repaired.

#### BUCKHORN.

The ice lifted two of the piers and broke the guide boom to the slide. In order to prevent constant stoppage to navigation, two piers were built about half a mile below the lock, to which a boom will be attached. This will provide a navigation channel clear of the logs.

#### BURLEIGH.

The apron of the large slide was taken out by the logs. A new apron was put on, also a new apron was put in the small slide. The apron in the small slide was raised so that not so much water is used in running logs.

#### YOUNG'S POINT.

The boom leading into Clear Lake was broken by the ice. This was repaired and two rounds of timber placed on the piers at the entrance.

## KATCHEWANNOE LAKE.

The anchors of the boom in several places were dragged by the ice. These were replaced. This boom is of great benefit both to lumbermen and navigation.

## PETERBORO'.

Two crab winches mounted on small trucks, which run on a track, were placed on the dam. The apron on one of the slides was rebuilt and some minor repairs were done to the booms and piers. A short boom was placed from the railroad bridge to the first pier.

## OTANABEE RIVER.

The accumulations of sawdust at the mouth of the river at Rice Lake became so great that it was stopping navigation. It is almost impossible to get rid of this nuisance. A large heavy rake was attached to a scow, and this was dragged backwards and forwards through the sawdust. This rake agitated the sawdust, and it was carried away by the current. A fair navigation channel was thus formed.

## HASTINGS.

The guide booms were broken by the ice, and part of the lower end of the slide pier was taken out. These were repaired. Some three years ago the dues were taken off the slides at Heeley's Falls, Middle Falls and Chisholm's Rapids, in consideration that the lumbermen would keep the slides in repair. Very little repairs have been done by them, and the slides are in poor condition. If this state of things continues, I would recommend that the dues be again imposed, and the slides kept in proper repair by this department.

I have the honour to be, Sir,

Your obedient servant,

RICH D. B. ROGERS,  
*Superintending Engineer.*

The Acting Chief Engineer,  
Department of Public Works,  
Ottawa.

STATEMENT showing the total number of pieces of sawlogs, boom timber, cedar railway ties, that passed through the different slides on the River Trent and Newcastle District Works, for the fiscal year ended 30th June, 1891.

Station	Sawlogs.	Boom Timber	Cedar ft.	Cedar, s. ft.	Railway Ties.	Telegraph Poles.
St. Catharines Falls	15,107	797				
Rocky Falls	31,000	1,000				
Thornhill	504,000	1,000				
Thornhill Falls	504,000	1,000				
Yamouche Point	504,000	1,000				
Calumet	504,000	1,000				
Peterborough	504,000	1,000				
Hastings	504,000	1,000				
Hastings Falls	504,000	1,000	4,137	1,000	20,917	16
St. Catharines Falls	504,000	1,000				

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**APPENDIX No. 8.**

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**REPORT**

ON

**GOVERNMENT TELEGRAPH LINES,**

**FOR THE FISCAL YEAR ENDED 30TH JUNE, 1891.**

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## APPENDIX No. 8.

### GOVERNMENT TELEGRAPH LINES.

TELEGRAPH SERVICE OFFICE,  
DEPARTMENT OF PUBLIC WORKS,  
OTTAWA, 6th August, 1891.

SIR,—I have the honour to submit the following report upon the Telegraph Service for the twelve months ended 30th June, 1891, with tabular statements of lines, operating staff, &c., established in the several districts.

I have the honour to be, Sir,

Your obedient servant,

F. N. GISBORNE,  
*General Superintendent Government Telegraph Lines.*

E. F. E. ROY, Esq.,  
Secretary, Department of Public Works.

### TELEGRAPH SERVICE—1890-91.

#### NEWFOUNDLAND.

The extension line connecting "Cape Ray with Port au Basque," 14 miles in length, has been operated and maintained, at a cost of \$250 per annum, as in previous years, under an agreement entered into with the Anglo-American Telegraph Company.

#### MARITIME PROVINCES.

The Sydney-Meat Cove line, and the cable thence to the Magdalen Islands, has remained in good working order throughout the year, and 1,600 new poles have been delivered *in situ* for renewing 50 miles of the route during the present summer. Poles have also been delivered *in situ* for the construction of a branch loop line, 7 miles in length, to White Point, C. B., which will be erected during this summer; the required additional sum of \$350, beyond last year's appropriation, having been provided for in the estimates.

The "Mabou to Cheticamp," Cape Breton, line, 60 miles in length, in good working order throughout the year.

The "Grand Manan-Campobello," Bay of Fundy, cable again ceased working on the 3rd May, 1890, and was repaired on the 24th September, the service of the SS. "Newfield" not being available before that date. District Superintendent Hartley Gisborne then reported that the cable had been broken by a vessel's anchor one mile out from Campobello Island, that said cable was in bad condition, having been already spliced in 17 places. It was finally renewed as follows:—

	Nautical Miles.
Old shore end previously laid, about .....	0-25
New shore end .....	1-41
New intermediate .....	2-55
Old deep sea, about .....	2-55
Old shore end, previously laid .....	0-25
Total .....	7-01

with a recommendation that when next out of order new shore end cable should replace the old deep sea portion.

N. B.—This cable again gave out 9th May, 1891, but cannot be repaired until the services of the SS. "Newfield" will be available, about the end of August next.

A branch line has now been constructed between Grand Harbour Station, Grand Manan, and Whitehead Island, 6½ miles, including two cables of 53 and 71 nautical miles in length, and has remained in good working order.

The "Cape Sable Island," N. S., line has continued in good working order throughout the past year.

#### RIVER AND GULF OF ST. LAWRENCE.

The "Grosse Isle Quarantine" land lines and heavy cables have remained in good order throughout the year.

The "Manicouagan-Godbout" cable, 30 miles in length, after being operated with much difficulty for several months was repaired by the Assistant Superintendent, the damage being about half a mile distant from Godbout. Nearly one inch of the copper conductor had been entirely corroded away, the water completing an imperfect circuit.

The "North Shore land lines"—Chicoutimi and Point Esquimaux—586 miles in length, were satisfactorily operated throughout the year, to the marked benefit of the fishing population of that district. Throughout the entire route a traversable pathway has been cut out through the forest, shelter huts have been constructed and many bridges built, flat boats or canoes being placed at the widest river crossings. The winter mail carriers greatly appreciate such necessary accommodation, and it will be advisable to gradually improve all such facilities by small annual grants for the service.

A cable from "Long Point of Mingan, North Shore St. Lawrence, to Mechastie Bay." At present, 204 miles in length, was successfully laid by District Superintendent Hartley Gisborne on 19th August, 1890, the cable having last previously been broken when 14 knots had been paid out, in order to save the life of Jos. McDonald, one of the workmen, who was entangled in it, as it was being paid out from the tank. McDonald, whose leg and ribs were broken, has happily since recovered and is now again on duty. A few weeks after the cable had been laid a fault developed itself, which has since been located by the Assistant Superintendent at the point where the cable was broken, as above explained, and it will be repaired by him so soon as the SS. "Newfield" is available to such service.

The "Rock Cable," as mentioned in my last annual report, has been removed. This cable was submerged, or drowned, 1880—1920 nautical miles—and was being spliced, eight times, it was then determined (per Order in Council) to connect the same between the Grand Manan Station and St. Paul's Island. It was successfully connected by the District Superintendent Hartley Gisborne in 15 sections, of which 14, 10 nautical miles each, were 140 miles shore end and were in good order, the remaining 10 nautical miles was by grossly damaged and 57 nautical miles of the same cable was submerged. When the cable had rested on the bottom, it was exposed, it was given a coat as when submerged; but over a week afterwards it was found to be almost entirely corroded away.

The "St. Paul's Island Cable," 100 nautical miles in length, was made up from the old cable of the "Rock Cable," and was a new cable, and was, under the management of the Assistant Superintendent, successfully submerged in 15 sections, of which 14, 10 nautical miles each, were 140 miles shore end and were in good working order.

The "Cape Sable Island Cable," 100 nautical miles in length, has been satisfactorily operated throughout the year. A branch line, one mile in length, was constructed between the station and the island, New Brunswick, and has remained in good working order throughout the year.

## ONTARIO.

The Bath-Amherst Island and Kingston-Wolfe Island land lines and cables have been satisfactorily worked since their transfer, at a nominal rental, to the North American Telegraph Company.

The Leamington-Pelee Island cable and land telephone lines have worked satisfactorily; but the cable 10 miles in length, has ceased working since 2nd June, probably from damage by a vessel's anchor. The Assistant Superintendent will shortly proceed to Lake Erie for the purpose of repairing the damage.

## NORTH-WEST TERRITORY.

The Qu'Appelle-Edmonton line *via* Battleford has worked in a satisfactory manner; and the Clarke's Crossing-Prince Albert branch, 83 miles in length, has been transferred to the Canadian Pacific Railway Company.

## BRITISH COLUMBIA.

The Victoria-Cape Beale telephone line, 115 miles in length, has been completed, and the advisability of converting it into a telegraph line, with skilled operators, is now under consideration.

The Ashcroft-Barkerville line, 273 miles in length, has been entirely repoled, and is now in satisfactory working order.

## REVENUE AND EXPENDITURE.

The following table shows the revenue and expenditure figures for each of the lines in the several districts covered by the foregoing report:—

	Revenue.	Expenditure.	Remarks.
	\$ cts.	\$ cts.	
Gulf of St. Lawrence and Maritime Provinces:			
Anticosti Island line.....	865 81	2,433 94	Signal service and meteorological service messages transmitted free of charge.
Magdalen Islands.....	649 10	2,117 09	
Ment Cove line.....	1,349 62	1,555 81	
Cape Sable do.....	54 52	224 73	
Escuminac do.....	136 23	434 02	
Cheticamp do.....	291 87	598 81	
Bay of Fundy line.....	440 70	2,349 48	
Quarantine do.....	617 97	493 92	
North Shore of St. Lawrence (W.B.) line.....	2,867 86	3,171 20	
do do (E.B.) do.....	936 81	4,013 81	
Cape Ray, Newfoundland, line.....		250 00	
Low Point, C.B., line.....		50 00	
Subsidies, stationery, line and office material, cable repairs and contingencies, chargeable to the appropriation for Gulf lines.....		11,427 57	
	8,210 49	29,120 38	
Ontario-Pelee Island line.....	106 75	217 66	
	8,317 24	29,338 04	
North West telegraph line.....	4,859 95	22,389 14	
Total.....	13,177 19	51,727 18	

F. N. GISBORNE.

*Genl. Supt. Government Telegraph Service.*

1891 = 1892 = 1893 = 1894 = 1895 = 1896 = 1897 = 1898 = 1899 = 1900 =

1901 = 1902 = 1903 = 1904 = 1905 = 1906 = 1907 = 1908 = 1909 = 1910 =

Mean.

Standard  
Deviation

Index of  
Variation

1891

1892 = 1893 = 1894 = 1895 = 1896 = 1897 = 1898 = 1899 = 1900 =

1901 = 1902 = 1903 = 1904 = 1905 = 1906 = 1907 = 1908 = 1909 = 1910 =

1911 = 1912 = 1913 = 1914 = 1915 = 1916 = 1917 = 1918 = 1919 = 1920 =

1891. The commission is 20 per cent upon all fees  
paid to and from the office; said commission  
deducted 100 to 1, in lieu of the rate of 200  
per centum.

1891. The commission is 20 per cent upon all fees  
paid to and from the office; said commission  
deducted 100 to 1, in lieu of the rate of 200  
per centum.

# ANTICOSTI TELEGRAPH SYSTEM. ANTICOSTI ISLAND SERVICE.

STATIONS.	Intermediate Distances.	Operators.	Salaries per Annum.	Date of Appointment.	Memo.
	Miles.		\$ cts.		
1 *Fox Bay.....	0	J. Stubbart.....	50 00 or con'n.	Nov. 1, 1888.	N. B. The commission is 25 per cent on all business to and from the office; and commission guaranteed not to be less than at the rate of \$50 per annum.
2 Heath Point Lighthouse.....	23	T. Gagne.....	50 00	July 20, 1881.	
3 South Point Lighthouse.....	32½	A. Nadeau.....	50 00	Oct. 1, 1888.	
4 *Shallow Creek.....	17½	B. Bradley.....	50 00	July 7, 1881.	
5 Salt Lake.....	52½	J. Carbray.....	300 00	do 1, 1881.	General Repairer. Plus \$1 per day when absent on duty.
6 South West Point Lighthouse.....	15	Miss G. Pope.....	200 00	Oct. 18, 1880.	Chief Operator since 1st August, 1882.
		E. Pope.....	100 00	Aug. 1, 1882.	District Superintendent. Plus \$1 per day when absent on duty.
7 Jupiter River.....	7		50 00		
8 Otter River.....	17½		50 00		
9 *Beesie River.....	22	M. Duguay.....	50 00	Oct. 1, 1886.	
10 Cape Eagle (Ellis Bay).....	10		50 00		
11 West Point Lighthouse.....	14	A. Malouin.....	50 00	Aug. 1, 1881.	NOTE—A special allowance for maintenance of office, \$50 per annum, has been added to the commission for offices marked*, since September, 1887.
12 *English Bay.....	3	F. Cabot.....	50 00	July 1, 1882.	
Totals.....	214		1,160 00		

## GASPE SECTION.

1 *Anse-a-Figuere.....		N. Bernier.....	17 00	do	N. B. A special allowance for the cable terminus.
2 Gaspe Basin.....	28	J. J. Amett.....	150 00	Oct. 16, 1881.	A testing station only.
	28		200 00		

## GOVERNMENT TELEGRAPH SERVICE.—Continued.

## MAGDALEN ISLANDS TELEGRAPH SYSTEM.

## MAGDALEN ISLANDS SECTION.

Station.	Intermittent Persons.	Operators.	Salaries per Annum.	Date of Appointment.	Memo.
1. <i>Stationer</i>	M. S.	M. S. J. S. S.	\$ cts.		
2. <i>Assistant Stationer</i>	0		50 00	Oct. 1, 1882	N. B.—The commission is 25 per cent on all business to and from the office; said commission guaranteed not to be less than at the rate of \$50 per annum.
3. <i>Stationer</i>	0		50 00	June 11, 1881	
4. <i>Stationer</i>	0		400 00	Dec. 1, 1881	
5. <i>Stationer</i>	0		50 00	do 1, 1881	
6. <i>Stationer</i>	0		50 00	do 1, 1883	
7. <i>Stationer</i>	0		50 00	Aug. 9, 1883	
8. <i>Stationer</i>	0		500 00	do 17, 1880	
9. <i>Stationer</i>	0		50 00	June 1, 1888	
10. <i>Stationer</i>	0		200 00	June 1, 1888	
11. <i>Stationer</i>	0		50 00	Feb. 18, 1882	
12. <i>Stationer</i>	0		1,400 00		
13. <i>Stationer</i>	0				
14. <i>Stationer</i>	0				
15. <i>Stationer</i>	0				
16. <i>Stationer</i>	0				
17. <i>Stationer</i>	0				
18. <i>Stationer</i>	0				
19. <i>Stationer</i>	0				
20. <i>Stationer</i>	0				
21. <i>Stationer</i>	0				
22. <i>Stationer</i>	0				
23. <i>Stationer</i>	0				
24. <i>Stationer</i>	0				
25. <i>Stationer</i>	0				
26. <i>Stationer</i>	0				
27. <i>Stationer</i>	0				
28. <i>Stationer</i>	0				
29. <i>Stationer</i>	0				
30. <i>Stationer</i>	0				
31. <i>Stationer</i>	0				
32. <i>Stationer</i>	0				
33. <i>Stationer</i>	0				
34. <i>Stationer</i>	0				
35. <i>Stationer</i>	0				
36. <i>Stationer</i>	0				
37. <i>Stationer</i>	0				
38. <i>Stationer</i>	0				
39. <i>Stationer</i>	0				
40. <i>Stationer</i>	0				
41. <i>Stationer</i>	0				
42. <i>Stationer</i>	0				
43. <i>Stationer</i>	0				
44. <i>Stationer</i>	0				
45. <i>Stationer</i>	0				
46. <i>Stationer</i>	0				
47. <i>Stationer</i>	0				
48. <i>Stationer</i>	0				
49. <i>Stationer</i>	0				
50. <i>Stationer</i>	0				
51. <i>Stationer</i>	0				
52. <i>Stationer</i>	0				
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63. <i>Stationer</i>	0				
64. <i>Stationer</i>	0				
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66. <i>Stationer</i>	0				
67. <i>Stationer</i>	0				
68. <i>Stationer</i>	0				
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70. <i>Stationer</i>	0				
71. <i>Stationer</i>	0				
72. <i>Stationer</i>	0				
73. <i>Stationer</i>	0				
74. <i>Stationer</i>	0				
75. <i>Stationer</i>	0				
76. <i>Stationer</i>	0				
77. <i>Stationer</i>	0				
78. <i>Stationer</i>	0				
79. <i>Stationer</i>	0				
80. <i>Stationer</i>	0				
81. <i>Stationer</i>	0				
82. <i>Stationer</i>	0				
83. <i>Stationer</i>	0				
84. <i>Stationer</i>	0				
85. <i>Stationer</i>	0				
86. <i>Stationer</i>	0				
87. <i>Stationer</i>	0				
88. <i>Stationer</i>	0				
89. <i>Stationer</i>	0				
90. <i>Stationer</i>	0				
91. <i>Stationer</i>	0				
92. <i>Stationer</i>	0				
93. <i>Stationer</i>	0				
94. <i>Stationer</i>	0				
95. <i>Stationer</i>	0				
96. <i>Stationer</i>	0				
97. <i>Stationer</i>	0				
98. <i>Stationer</i>	0				
99. <i>Stationer</i>	0				
100. <i>Stationer</i>	0				

MAGDALEN ISLANDS TELEGRAPH SYSTEM.  
CAPE BRETON SECTION.

8-1114

STATIONS.	Intermediate Distances.	Operators.	Salaries per Annum.	Date of Appointment.	Memo.
	Miles.		\$ cts.		
1 Meat Cove (Cable Station).	0	A. B. McDonald.	420 00	Nov. 7, 1880	<p>N. B. The commission is 25 p. c. upon all business to and from the office; said commission guaranteed not to be less than at the rate of \$50 per annum. This line is at present operated and maintained by the Western Union Telegraph Company, but at the cost of the Government.</p>
2 Aspy Bay	10½	R. G. Zwicker	50 00 or comm'n.	Aug. 1, 1882	
3 Neil's Harbour (½-way house.)	15	M. McLeod.	50 00	April 1, 1887	
4 Ingouish, North Bay	9	J. M. Burke.	50 00	do 1, 1882	
5 South Ingouish	10½	Miss A. A. Baker.	50 00	July 1, 1880	
6 French River.	23	John McDonald	50 00	April 1, 1883	
7 St. Ann's, South Bay	19	Miss C. Morrison.	50 00	do 1, 1884	
8 Baddeck, (Loop Line).	13	Miss Dunlop.	50 00	do 1, 1882	
9 Englishtown	6	Miss Bingham	50 00	July 19, 1882	
10 Kelly's Cove, (N. Campbellton).	2	Miss M. C. Campbell.	50 00	April 1, 1885	
11 Big Bras d'Or.	5	Mrs. E. Livingston	50 00	Jan. 1, 1885	
12 North Sydney	12½		50 00	do	
Totals	128½		920 00		

CAPE MEXICO TELEGRAPH SYSTEM—Continued.

# CAPE MEXICO TELEGRAPH SYSTEM.

1891-1892.

Mexico.

The commission is 25 per cent upon all business to and from the office; said commission guaranteed to be not less than at the rate of \$50 per annum.

N. B. The commission is 25 per cent upon all business to and from the office; said commission guaranteed not to be less than at the rate of \$50 per annum.

## LAKE POINT, CAPE MEXICO SECTION.

		50 00 in com'n			
1891	0				
1892	0	50 00	do	Aug. 1, 1891	
Total		100 00			

## EAST COAST SECTION.

N. B. In connection with the Signal Station a land line 200 miles in length has been erected between Cancun and Halifax for a bonus of \$16,000, and is now maintained and operated by the Western Union Telegraph Company without further cost to the Government.

## MAHON' CHETICAMP, C.B., TELEGRAPH SYSTEM.

STATIONS.	Inter- mediate Distances.	Operators.	Salaries per Annum.	Date of Appointment.	Memo.
1 Mahon.....	Miles. 0	Mrs. M. McDonald.....	\$ cts. 50 00 or con'n.	April 1, 1887	N.B. The commission is 25 p. c. of the Government line tariff receipts, and is guaranteed to amount to not less than \$50 per annum.
2 Broad Cove.....	20	Mrs. A. Campbell.....	do	Sept. 1, 1887	
3 Margaree Harbour.....	17	Mrs. M. A. McLellan.....	do	April 1, 1887	
4 N. E. Margaree (loop, 5 miles) Loop Line wire.....	10	Miss B. M. Rose.....	do	Jan. 1, 1889	
5 Cheticamp.....	16	Mrs. M. Finet.....	do	April 1, 1887	
Totals.....	63				

## CHATHAM-ESCUMINAC, N. B., TELEGRAPH SYSTEM.

1 Chatham.....	0	Great North-Western Telegraph Co.	185 00		This amount is paid for supervision of the line and office accommodation at Chatham.
2 Black Brook.....	5½		50 00 or con'n.		The commission is 25 per cent of the Government line tariff receipts, and is guaranteed to amount to not less than \$50 per annum.
3 Bay du Vin.....	15	Miss M. Williston.....	50 00	do .. March 1, 1885	
4 Lower Hardwicke.....	6	Mrs. M. Brimmer.....	50 00	do .. Aug. 1, 1891	
5 Escuminac.....	3½	Mrs. A. Lewis.....	50 00	do .. Sept. 1, 1885	
6 Point Escuminac Lighthouse.....	12	H. W. Phillips, jun.....	50 00	do .. Feb. 1, 1885	
Totals.....	42		435 00		



GOVERNMENT TELEGRAPH SERVICE—Continued.  
GROSSE ISLE QUARANTINE TELEGRAPH SYSTEM.

STATIONS.	Inter- mediate Distances.	Operators.	Salaries per Annum.	Date of Appointment.	Memo.
	Miles.		\$ cts.		
1 Quebec.....	0	Great North-Western Telegraph Co.	185 00.		This amount is paid for supervision of the line, and covers rent of pole line in Quebec to L'Ange Gardien, for which \$35 per annum is charged.
2 L'Ange Gardien..... St. Pierre (3 mile cable).....	13 4	C. Turcott.....	30 00 or con'n.	Mar. 1, 1885	
3 Ste. Pétronille.....	4½	Mrs. Blais.....	50 00	do Oct. 1, 1887	This commission is 25 per cent of the Government line tariff, and is guaranteed to amount to not less than \$30 per annum.
4 St. Laurent.....	6½	M. Gobeil.....	50 00	do Sept. 15, 1888	
5 St. Jean.....	7	P. Poëliot.....	50 00	do July 1, 1888	
6 St. François (including 4 miles cable).....	5½	M. Enmond.....	50 00	do Mar. 1, 1885	
7 Grosse Isle quarantine office.....	7	M. Langlois.....	50 00	do Sept. 1, 1885	
8 do hospital.....	1½	(Telephone).....			
Total.....	50½		485 00		

[1891]

## CHICOUTIMI AND NORTH SHORE OF ST. LAWRENCE TELEGRAPH SYSTEM.

## CHICOUTIMI SECTION.

STATIONS.	Inter- mediate Distances.	Operators.	Salaries per Annum.	Date of Appointment.	Memo.
	Miles.		\$ cts.		
1 Bay St. Paul.	0	F. Babin.	50 00	Previous to April 1, 1885.	The commission upon business is 25 per cent of the Government tolls of the line; the amount guaranteed to be not less than \$50 per annum.
2 St. Urbain.	9	A. Babin.	50 00	do	
3 Lac Cuvette.	37	A. Gauthier (Repairer).	50 00	do	
4 St. Alexis.	31½	G. Pelletier.	420 00	May 15, 1887.	
5 St. Alphonse-de-Bagotville.	3	A. Simard.	50 00 or com'n.	Jan. 1, 1889.	
6 Chicoutimi.	11½	D. Boly.	50 00	April 1, 1885.	
Total.	92		720 00	do 28, 1890.	

## NORTH SHORE SECTION.

STATIONS.	Inter- mediate Distances.	Operators.	Salaries per Annum.	Date of Appointment.	Memo.
	Miles.		\$ cts.		
1 Murray Bay.	0	Mrs. F. Vincent.	50 00	Previous to April 1, 1885.	Closed 31st March, 1891. Portneuf Mills office closed June, 1890.
2 Cap. L'Anglo.	4	N. Duchesne.	50 00	June 1, 1888.	
3 Ste. Fidele.	6	A. N. Paré.	50 00	April 1, 1890.	
4 Port au Peul.	7	A. Brassard.	50 00	May 1, 1889.	
5 St. Siméon.	4	D. Gaudin.	50 00	Dec. 1, 1887.	
6 Baie des Rochers.	12	G. Savard.	50 00	June 1, 1887.	
7 Riv. aux Canards.	17	G. Bouillon.	50 00	Nov. 1, 1890.	
8 St. Etienne.	17	N. Caron (Repairer).	420 00	Sept. 1, 1889.	
9 Tadoussac (1¼ mile cable).	13	J. E. Caron.	50 00 or com'n.	Nov. 1, 1888.	
10 Bergeonne.	15	M. Savard.	50 00	do 1, 1888.	
11 Beccomais.	12	J. H. Topping.	50 00	April 1, 1885.	
12 Petit Romane.	8	J. A. Pulce.	50 00	do	
13 Mille Vaches.	8	J. A. Pulce.	50 00 or com'n.	April 1, 1885.	
14 Portneuf Mills.	11½		50 00	do	

13	Portneuf Light	0	S. Blanchard	50 00 or com'n	July	1, 1889
14	Sault au Cochon	7	E. Courteau (Repairer)	425 00	April	1, 1888
17	Belleville	7	J. Fiset	50 00 or com'n	Dec.	1, 1887
18	Pointe aux Outardes (cable)	31	R. H. Montgomery	50 00 do	Oct.	1, 1889
19	Pointe Paradis, Manicouagan	12	F. C. Ouellet	500 00 per annum	Aug.	8, 1880
20	River Godbout (cable)	26	N. A. Comeau	50 00 or com'n	Oct.	13, 1883
21	Pointe des Monts	184	L. F. Faffard	50 00 do	Dec.	24, 1883
22	Trinity Bay West	34	Z. Poulin	50 00 do	May	16, 1884
23	Trinity Bay East	24	A. Bilodeau	Accommodation of	do	1, 1889
24	Caribou Islands	7	I. Comeau	do	Sept.	1, 1889
25	Pentecost River	17	Dist. Supt.'s Office			
26	Ste. Marguerite	473	A. Thériault	180 00	July	1, 1888
27	Seven Islands	223	P. E. Vignault	180 00	Jan.	2, 1884
28	River Montic	153	D. Poirier	50 00	May	1, 1885
29	Sheldrake	72	P. Touzel	50 00 or com'n	Nov.	1, 1888
30	Thunder River	63	H. LeBrun	50 00 do	Feb.	1, 1880
31	Magpie	14	Geo. Molloy	50 00 do	Oct.	1, 1880
32	St. John's River	9	B. Chambers	50 00 do	do	1, 1889
33	Long Point	10	J. Vibert	50 00 do	Nov.	1, 1889
34	Mingan	7	M. J. Maloney	50 00 do	Oct.	1, 1889
35	Pointe aux Esquimaux	24	A. Lausier	420 00 do	do	1, 1889
Total		486				

NOTE. — In the estimates the maintenance of the Chicoutimi and North Shore lines is provided for under head of North Shore Line. They are operated conjointly.



LINE IN THE NORTH-WEST TERRITORY.  
QU'APPELLE EDMONTON SECTION.

No.	Stations.	Intermediate Distances.	Operators.	Salaries per Annum.	Date of Appointment.	Memo.
		Miles.		\$ cts.		
1	Qu'Appelle.....	0	E. W. Warner.....	720 00	Jan. 1, 1883.	
2	Fort Qu'Appelle.....	17	Miss E. Johnston.....	600 00	Mar. 1, 1885.	
3	Touchwood.....	46	A. Von Lindeburg.....	600 00	Nov. 1, 1883.	
4	Humbolt.....	78	A. Guimont.....	600 00	May 1, 1884.	
5	Saskatoon (14 miles Loop).....	69	R. J. Molloy, Agent.....	720 00	do 1, 1884.	
6	Henrietta.....	52	J. Harrington, Repairer.....	600 00	Jan. 1, 1888.	
7	Battleford.....	47	W. Salisbury, Repairer.....	720 00	Oct. 1, 1886.	
			L. P. O. Noel.....	720 00	Apr. 15, 1890.	
8	Fort Pitt.....	89	H. Sikes, Repairer.....	600 00	May 1, 1889.	
9	Moose.....	45A	W. M. McDonald, Rpr.....	600 00	Apr. 15, 1890.	
10	Saddle Lake.....	45	Geo. Voyer, Repairer.....	600 00	Oct. 1, 1889.	
11	Victoria.....	37	J. F. Lake.....	600 00	do 1, 1889.	
12	Fort Saskatchewan.....	49	W. C. Gillis, Repairer.....	720 00	Jan. 1, 1887.	
13	Edmonton.....	24	W. G. Ross, Agent.....	Com. 25 p. c.	Dec. 1886.	
			A. Taylor, Agent.....	720 00	Prev. to 1892.	
			W. McKay, Repairer.....	720 00	May 1, 1886.	
<i>Branch Line</i>						
	*Edmonton.....	0				
14	St. Albert.....	9				
Total.....		607 1/2				

\* The St. Albert branch line is operated with telephones.

GOVERNMENT TELEGRAPH SERVICE—Continued.

NORTH WEST TELEGRAPH LINE: WOOD MOUNTAIN AND FORT MACLEOD STATIONS.

Station.	Length of line. Miles.	Estimated cost, Annual.	Time of completion.	Notes.
Fort Macleod to head of river, with bridge Mileage Fort Macleod— 10.00 Head of river— 10.00 Total— 20.00	20.00	\$ 4,000	Sept. 1, 1885. Oct. 1, 1890	The Fort Macleod line has been sold to the North West Coast and Navigation Co.
Head of river to Wood Mountain Mileage Head of river— 10.00 Wood Mountain— 10.00 Total— 20.00	20.00	\$ 4,000	Sept. 1, 1885. Oct. 1, 1890	The Wood Mountain line has been operated by tele- phone since May, 1890.

GOVERNMENT TELEGRAPH SERVICE IN BRITISH COLUMBIA.  
ASHCROFT-BARKERVILLE

Office	Inter- mediate Distances.	Names.	Positions.	Salaries per Month.	Date of Appointment.	Memo.
	Miles.			\$	cts.	
Ashcroft Station	0	C. P. Ry. Telegraph.				
Cache Creek	4	H. L. Good	Operator and repairer.	60 00	Feb. 16, 1885.	
Clinton	26	J. A. Le Bourdais.	do	50 00	do 1885.	
Bridge Creek	53	W. Walker	do	50 00	May 1, 1890.	
Soda Creek	78	H. Yeates.	do	60 00	June 1, 1886.	This line is now operated by the Canadian Pacific Railway Co. for the Government. The arrangement being terminable at any time.
Quesnelle	54½	Miss I. Barlow.	Operator	47 00	Apr. 28, 1882.	
Stanley	48	Jac. Stone	Operator and repairer	83 33	Feb. 17, 1873.	
Barkerville	13					
	276½					
<i>Branch.</i>						
New Westminster						
Lachner's Landing (¼ mile cable)	18					This line was leased for 99 years to Messrs. J. A. Laidlaw and J. Wilson, on the 30th October, 1887.
Total	294½					

VICTORIA-CAPE BEALE.

Victoria	10					
Otter Point	26					
Port San Juan	40					
Carmanah Light-house	24					
Cape Beale	28					
Total	118					

This line is operated by the Canadian Pacific  
Railway Co. for the Government. The  
arrangement being terminable at any time.



APPENDIX No. 9.

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NAMES OF THE CHIEF OFFICERS

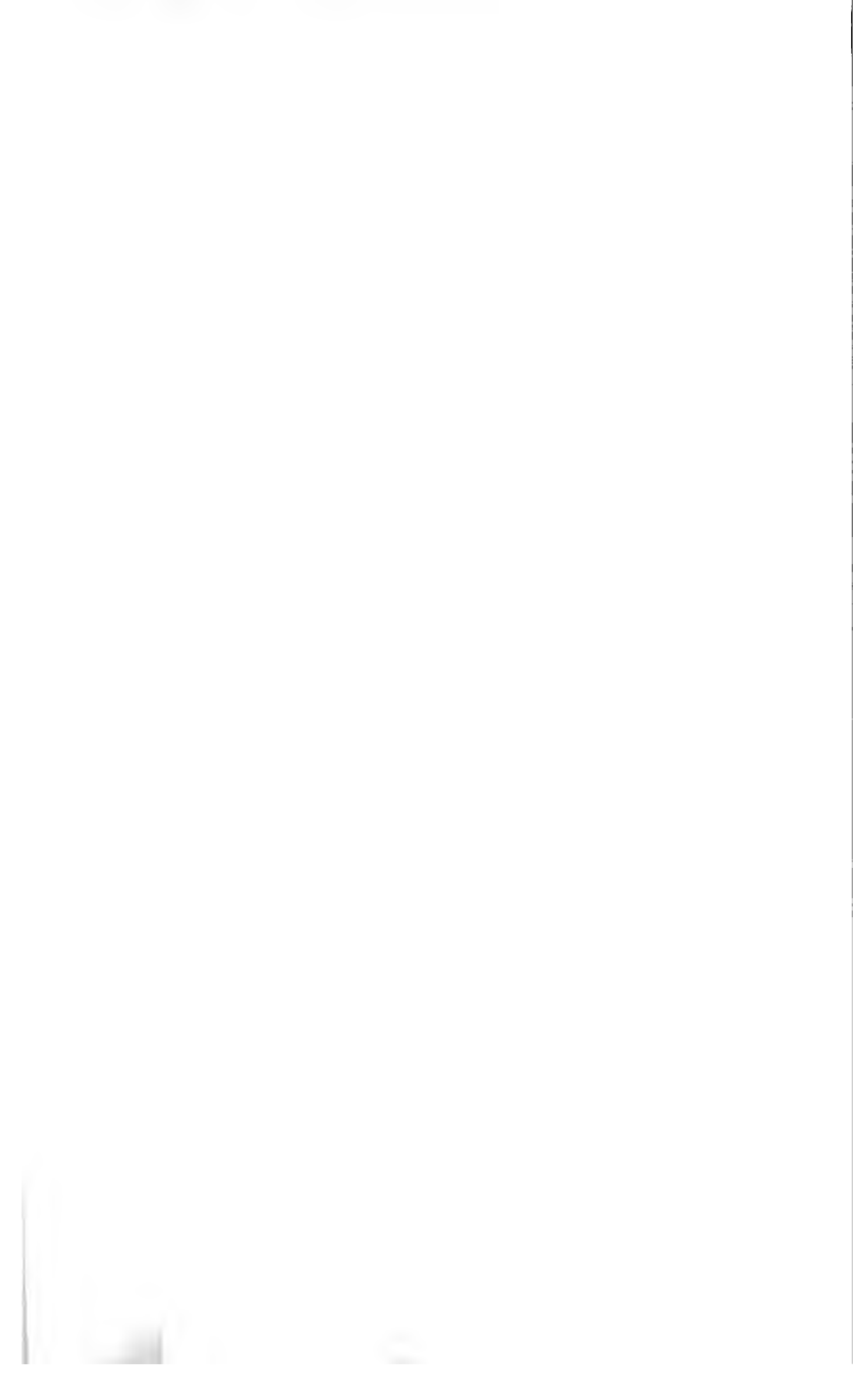
OF THE

DEPARTMENT OF PUBLIC WORKS,

WITH DATE OF APPOINTMENT, ETC.,

FROM

1841 TO 1892.



## APPENDIX No. 9.

THE NAMES with the date of appointment, &c., of the principal Officials of the Department of Public Works, from 1841 to 1892.

Names.	Capacity or Office.	Date of Appointment, Served.	
		From.	To.
<i>Under Statute 4-5 Vic., Cap. 38.</i>			
CORPORATION BOARD OF WORKS.			
Killaly, Hon. H. H. ....	Chairman .....	Dec. 29, 1841.	Oct. 3, 1844.
Daly, Hon. D. ....	Members .....		
Harrison, S. B. ....			
Davidson, J., Esq. ....	Secretary .....	Aug. 17, 1841.	
Begly, Thomas A. ....	Chief Engineer .....	do 17, 1841.	
Keefer, Samuel .....	Architect and Assistant Chief Engineer.....	Dec. 15, 1841.	
Rabidge, F. B. ....			
NEW BOARD OF WORKS.			
Killaly, Hon. H. H. ....	Chairman .....	Oct. 5, 1844.	June 8, 1846.
Daly, Hon. D. ....	Members .....		
Draper, Hon. W. H. ....			
Morris, Hon. W. ....			
Pajonau, Hon. D. B. ....			
<i>Under Statute 9th Vic., Cap. 37, &amp;c.</i>			
Robinson, Hon. W. B. ....	Chief Commissioner .....	July 4, 1846.	Mar. 10, 1848.
Tache, Hon. E. P. ....	do .....	Mar. 11, 1848.	Nov. 26, 1849.
Chabot, Hon. J. ....	do .....	Dec. 15, 1849.	Mar. 31, 1850.
Merritt, Hon. W. H. ....	do .....	April 20, 1850.	Feb. 11, 1851.
Bourret, Hon. J. ....	do .....	Feb. 15, 1851.	Oct. 27, 1851.
Yang, Hon. John.....	do .....	Oct. 28, 1851.	Sept. 22, 1852.
Chabot, Hon. J. ....	do .....	Sept. 23, 1852.	Jan. 26, 1855.
Lemieux, Hon. F. ....	do .....	Jan. 27, 1855.	Nov. 25, 1857.
Allyn, Hon. C. ....	do .....	Nov. 28, 1857.	Aug. 1, 1858.
Holton, Hon. L. H. ....	do .....	Aug. 2, 1858.	do 6, 1858.
Scotte, Hon. L. V. ....	do .....	do 6, 1858.	Jan. 10, 1859.
Ross, Hon. John. ....	do .....	Jan. 15, 1859.	June 12, 1861.
Cauchon, Hon. Jos. ....	Commissioner .....	June 15, 1861.	May 23, 1862.
Tower, Hon. U. J. ....	do .....	May 24, 1862.	May 27, 1863.
Drummond, Hon. L. T. ....	do .....	do 28, 1863.	July 23, 1863.
Laframboise, Hon. M. ....	do .....	July 23, 1863.	Mar. 29, 1864.
Chapais, J. C. ....	do .....	Mar. 30, 1864.	June 30, 1867.
Cagrain, Hon. Chas. Eus. ....	Second Commissioner..	Aug. 1, 1846.	
Cameron, Hon. M. ....	Assistant Commissioner ..	Mar. 11, 1848.	
Wenthall, John. ....	do .....	Feb. 2, 1850.	
Bourret, Hon. Jos. ....	do .....	April 20, 1850.	
Killaly, Hon. H. H. ....	do .....	Feb. 15, 1851.	
Keefer, Samuel .....	Deputy Commissioner.....	May 6, 1859.	
Tribau, Toussaint .....	do .....	Mar. 15, 1864.	
Begly, Thomas A. ....	Secretary .....	Sept. 25, 1847.	
Tribau, Toussaint .....	do .....	Dec. 13, 1859.	
Baum, Frederick .....	do .....	March 8, 1864.	
Pape, John .....	Chief Engineer .....	Oct. 31, 1853.	July 2, 1890.

APPENDIX No. 9.—The names with the date of appointment, &c., of the principal Officials of the Department of Public Works, from 1841 to 1892—*Concluded.*

Names.	Capacity or Office.	Date of Appointment Served.	
		From.	To.
Under Statute 31 Vic., Chap. 32.			
McDonnell, Hon. Wm.	Minister	July 1, 1867.	Oct. —, 1869.
Langens, C.R., Hon. Hector L.	do	Dec. 7, 1869.	Nov. 5, 1873.
McKenzie, Hon. Alexander.	do	Nov. 7, 1873.	Oct. 16, 1878.
Tupper, C.R., K.C.M.G., Sir Charles	do	Oct. 17, 1878.	May 20, 1879.
*Langens, C.R., K.C.M.G., Sir Hector L.	do	May 20, 1879.	Sept. 8, 1891.
Smith, Hon. Frank	Acting Minister	Aug. 14, 1881.	Jan. 11, 1892.
Quimet, Hon. Joseph Aldric	Minister.	Jan. 11, 1892.	
Trochu, Trochu	Deputy Minister	July 1, 1867.	
Bailhugot, G. F.	do	July 1, 1867.	Dec. 18, 1891.
Gobeil, A.	do	July 1, 1867.	
Chaplain, S.	Secretary	July 1, 1867.	
Barton, F. H.	do	July 1, 1867.	
Gobeil, A.	do	July 1, 1867.	Dec. 18, 1891.
Bon, E. F. E.	do	July 1, 1867.	
McPherson, W. A.	Assistant Secretary	July 1, 1867.	
*Perier, H. F.	Chief Engineer	July 1, 1867.	
Bailhugot, G. F.	Assistant Chief Engineer	July 1, 1867.	
Sexton, Thos. S.	Chief Architect	July 1, 1867.	
Fulton, Thomas.	do	July 1, 1867.	

\* Designation rendered 11th August, 1881; accepted 30th Sept. 1881.

\* Mr. Louis Chate has been acting Chief Engineer since July, 1891.

**APPENDIX No. 10.**

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**STATEMENT OF STAFF EMPLOYED**

**ON THE**

**SLIDES AND BOOMS**

**THROUGHOUT THE DOMINION.**

APPENDIX No. 11

Table showing the names of the persons who have been appointed to the various offices of the Department of the Interior, from the 1st of January, 1870, to the 31st of December, 1890.

Name	Rank or Position	Date of Appointment	Salary	Remarks
John A. Macdonald	Minister of the Interior	1870	\$10,000	First appointment to Crown Timber Office, Ottawa, 23rd June, 1870. Clerk, Dept. of Inland Revenue, 1st July, 1870, to 30th June, 1880.
John A. Macdonald	Minister of the Interior	1880	\$10,000	First appointment to Crown Timber Office, Ottawa, 21st April, 1877. Clerk, Dept. of Inland Revenue, 1st April, 1883, to 30th June, 1889.
John A. Macdonald	Minister of the Interior	1889	\$10,000	Employed during the season of navigation, for 8 months each year. Date of first appointment, 26th May, 1891. Timber Counter, Ottawa, for Dept. of Inland Revenue, 7th Jan., 1894, to 30th June, 1899.
John A. Macdonald	Minister of the Interior	1890	\$10,000	Employed during the season of navigation, for 8 months each year. Date of first appointment, 1st May, 1872. Assistant Timber Counter, Ottawa, for Dept. of Inland Revenue, 7th Jan., 1884, to 30th June, 1890.
John A. Macdonald	Minister of the Interior	1891	\$10,000	Date of first appointment to Dept. of Inland Revenue, 3rd May, 1891.
John A. Macdonald	Minister of the Interior	1892	\$10,000	In addition to the Superintendent Works, there are employed on the Saguenay works 4 flagmen, at 70c. per day each, during the passing of the logs through the slides, which lasts one or two months.

## St. Maurice District.

Charles Labrie	Dec. 28, 1894	Superintendent	Three Rivers	Oct. 7, 1874	1,200 00 per annum	St. Maurice Works. Every year, during the timber running season, the officers in charge of the various stations employ 25 to 30 men during three or four months, at the rate of \$40 to \$1.10 per working day, inclusive of 40 to 50 cents per day per man paid for board to the Deputy Slide Masters and Boom Keepers; also, one clerk and foreman, at \$1 per day, two watchmen and one gate-keeper.
J. B. Normand	1887	Asst. Superintendent	Month of St. Maurice	April 25, 1881	3 00 per day	
Cyrus Lyndburner	1888	Foreman	do	Aug. 1, 1881	505 00 per annum	
N. Dagnieu	July 7, 1881	Paymaster	Three Rivers	Dec. 12, 1878	469 50 per annum	
Jos. Page	do 30, 1881	Boom Keeper	Cap aux Cornuilles	April 12, 1878	3 00 per day	
Arthur Rousseau	—	Slide Master	Shawenigan	July 24, 1885	305 00 per annum	
Louis St. Onge	—	Asst. Slide Master	do	Jan. 13, 1880	535 00 do	
Charles Laugel	Sept. 8, 1887	Foreman	Grand Mere	Mar. 15, 1872	2 00 per day	
Theophile Larue	—	Boom Keeper	Les Piles	April 1, 1866	469 50 per annum	
Frs. Lacroix	—	Asst. Boom Keeper	Les Grevs	Aug. 5, 1885	385 00 do	
Arthur Pellerin	—	Boom Keeper	do	—	—	
<i>Richelieu District.</i>						
Azaire Bienvenue	—	Boom Master	Belleville Station	Jan. 1, 1882	100 00 per annum	
<i>Ottawa District.</i>						
G. P. Brophy	Feb. 24, 1846	Superintendent	Ottawa	July 6, 1873	2,500 00 per annum	Ottawa River Works.—In addition to the above officers, &c., there are employed during the running season, one foreman on slide at \$1.50 and one assistant foreman at \$1.25 per day; also 25 to 30 labourers at from \$1 to \$1.40 per working day.
D. Scott	do 15, 1830	Accountant	do	Oct. 1, 1854	1,500 00 do	
J. C. Scott	June —, 1865	Measurer and Time Keeper	do	April 1, 1889	2 00 per day	
Wm. Kane	Dec. 24, 1820	Messenger	do	Aug. 1, 1867	1 25 do	
C. Leduc	July 8, 1846	Paymaster	do	May 1, 1888	1,200 00 per annum	
*Pierre St. Pierre	Mar. 13, 1853	Deputy Slide Master	Carillon	April 21, 1885	1 25 per day	Actively employed about 7 months.
D. Noonan	June 17, 1840	Boom Master	Gatineau	Mar. 21, 1878	500 00 per annum	Actively employed about 7 months. Oversees repairs in winter.
J. Souliere	Nov. 8, 1820	Deputy Slide Master	Chaudiere	—	2 00 per day	do
J. McDonell	do 1, 1818	do	Hull	Mar. 1, 1877	1 25 do	do
D. McFarlane	Feb. 25, 1830	do	Chats	do 27, 1860	480 00 per annum	Employed about 6 months. Oversees repairs in winter.
John Harvey	May 22, 1831	Slide Master	Amprior	July 12, 1882	2 50 per day	Employed about 3 months during season of navigation.
Joseph McCrea	Mar. 26, 1839	Boom Master	Springtown	May 15, 1880	300 00 per annum	Employed 5 months during season of navigation. Oversees repairs in winter.
Patrick Barry	do 27, 1838	Slide Master	High Falls	Mar. 10, 1888	300 00 do	
Duncan McLaren	Jan. 7, 1860	Deputy Slide Master	Portage du Fort	Sept. 7, 1881	456 25 do	do
J. G. Poupore	Feb. 27, 1857	do	Black River	Oct. 15, 1880	480 00 do	do
James Steen Rowan	Aug. 27, 1886	do	Lower Petawawa	Mar. 18, 1887	300 00 do	do
Wm. Thompson	May 3, 1843	do	Mountain	Oct. 10, 1879	1 25 per day	do
D. Carmichael	Sept. 26, 1813	do	Calumet	Aug. —, 1848	40 00 per month	do 6 months
A. Proudford	July 17, 1822	do	Coulonge	April 1, 1865	1 00 per day	do 6 months
H. R. Downey	May 16, 1846	do	Des Juchins	July 1, 1883	300 00 per annum	do 4 months
Jos. Dufault	Jan. 15, 1840	Boom Master	Dunoine	April 24, 1882	1 50 per day	do
Hugh Grant	Mar. 25, 1829	Deputy Slide Master	do	do 12, 1872	300 00 per annum	Employed during timber season. Employed 3 months during season of navigation. Will inspect works when required.
A. McEwen	Aug. 20, 1829	do	Rocher Capitaine	May 1, 1874	480 00 do	do
A. H. Johnson	Nov. 28, 1839	do	Chevaux	—	2 50 per day	Paid during season of navigation, 7 months.
G. T. Johnson	Sept. 10, 1841	do	do	—	1 75 do	Attends to repairs in winter.

\* Discharged 1st April, 1891.



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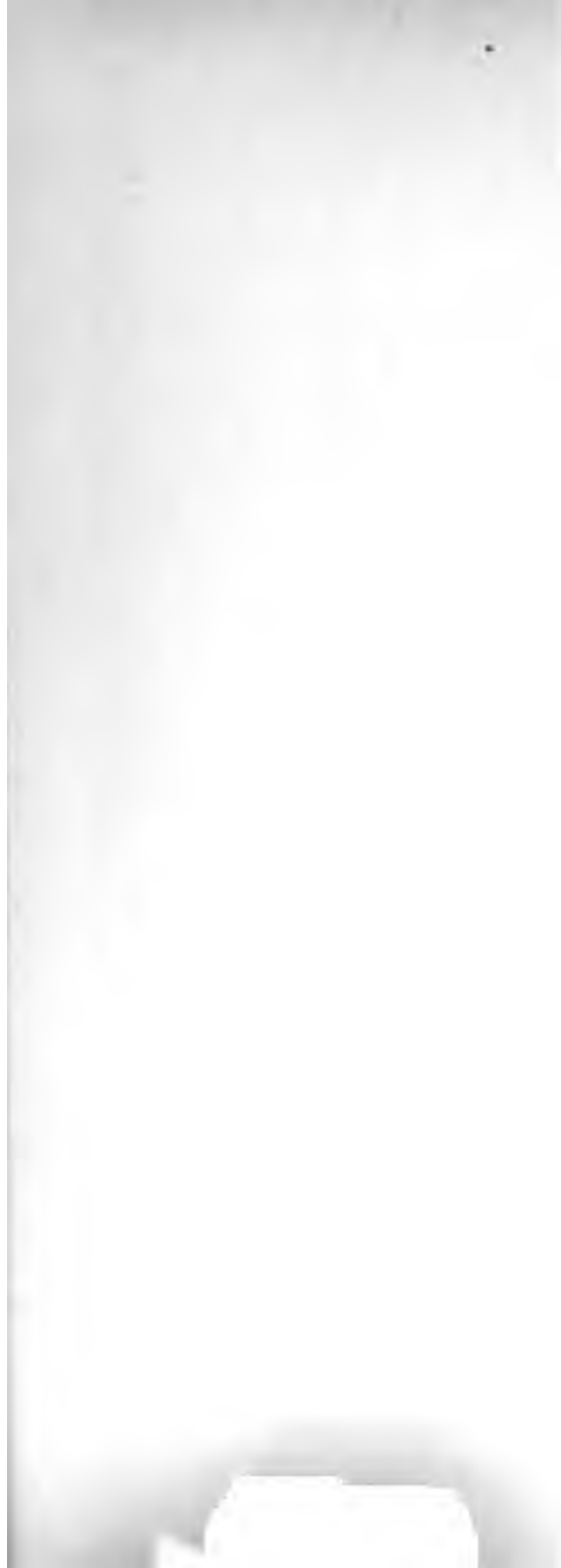
**APPENDIX No. 11.**

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**OFFICIAL CORRESPONDENCE**

**FROM 1ST JULY, 1867, TO 30TH JUNE, 1891.**

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## APPENDIX No. 11.

## OFFICIAL CORRESPONDENCE.

LETTERS Received and Sent from 1st July, 1867, to 30th June, 1891.

Years.				Received.	Sent.
1867	From 1st July to 31st December.....			2,075	1,511
1868	do	1st January to 31st December.....		3,498	2,317
1869	do	do do do.....		3,448	2,171
1870	do	do do do.....		4,961	3,185
1871	do	do do do.....		6,268	3,983
1872	do	do do do.....		8,333	4,428
1873	do	do do do.....		10,072	5,707
1874	do	do do do.....		9,800	5,043
1875	do	do do do.....		9,006	5,006
1876	do	do do do.....		7,971	4,773
1877	do	do do do.....		7,517	4,425
1878	do	do do do.....		6,886	4,021
1879	do	do do to 6th October.....		7,186	4,547
1879	do	7th October to 31st December.....		2,033	810
1880	do	1st January do.....		8,451	4,410
1881	do	do do do.....		9,599	5,529
1882	do	do do do.....		10,505	5,699
1883	do	do do do.....		11,633	6,227
1884	do	do do do.....		13,114	6,903
1885	do	do do do.....		8,977	5,321
1886	do	do do do.....		9,644	5,352
1887	do	do do to 30th June.....		4,866	2,735
1887	do	1st July do 1888.....		10,493	6,343
1888	do	do do 1889.....		10,522	7,042
1889	do	do do 1890.....		10,098	7,448
1890	do	do do 1891.....		10,576	7,286

NUMBER of Cheques sent by Accountant's to Secretary's Branch and Mailed, from 1882 to 1891.

Year.				No.
1882	From 22nd September to 30th June, 1883.....			1,566
1883	do	1st July do 1884.....		3,366
1884	do	do do do 1885.....		3,298
1885	do	do do do 1886.....		3,466
1886	do	do do do 1887.....		4,198
1887	do	do do do 1888.....		4,692
1888	do	do do do 1889.....		4,960
1889	do	do do do 1890.....		4,819
1890	do	do do do 1891.....		5,376

### CHEQUES issued by Finance Department and Mailed from Secretary's Branch.

Year.		No.
1885	From 1st April to 30th June, 1885	245
1885	do 1st July do 1886	954
1886	do do do 1887	1,158
1887	do do do 1888	918
1888	do do do 1889	887
1889	do do do 1890	908
1890	do do do 1891	790

### LETTERS Received and Sent, Chief Architect's Office, from 1st January, 1880, to 30th June, 1891.

Years.	Received.	Sent.
1880—From 1st January to 30th June		1,273
1880 do 1st July do 1881		2,943
1881 do do do 1882		2,859
1882 do do do 1883	3,538	4,600
1883 do do do 1884	3,869	6,004
1884 do do do 1885	4,500	6,718
1885 do do do 1886	6,075	6,450
1886 do do do 1887	6,216	6,390
1887 do do do 1888	6,947	6,870
1888 do do do 1889	6,254	7,667
1889 do do do 1890	7,448	6,578
1890 do do do 1891		7,751

\*The exact number of letters received cannot be accurately given, but would bear about the same proportion to letters sent as last year.

### LETTERS Sent from Chief Engineer's Office from January, 1880, to 30th June, 1891.

Year.	No.
1880—From 1st January to 30th June	418
1880 do 1st July do 1881	1,736
1881 do do do 1882	2,352
1882 do do do 1883	2,651
1883 do do do 1884	3,611
1884 do do do 1885	3,119
1885 do do do 1886	2,867
1886 do do do 1887	3,281
1887 do do do 1888	3,552
1888 do do do 1889	4,229
1889 do do do 1890	3,374
1890 do do do 1891	3,948

NOTE.—The letters, including returns, received in the Chief Engineer's Office may be estimated at the rate of two received to one sent.

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**APPENDIX No. 12.**

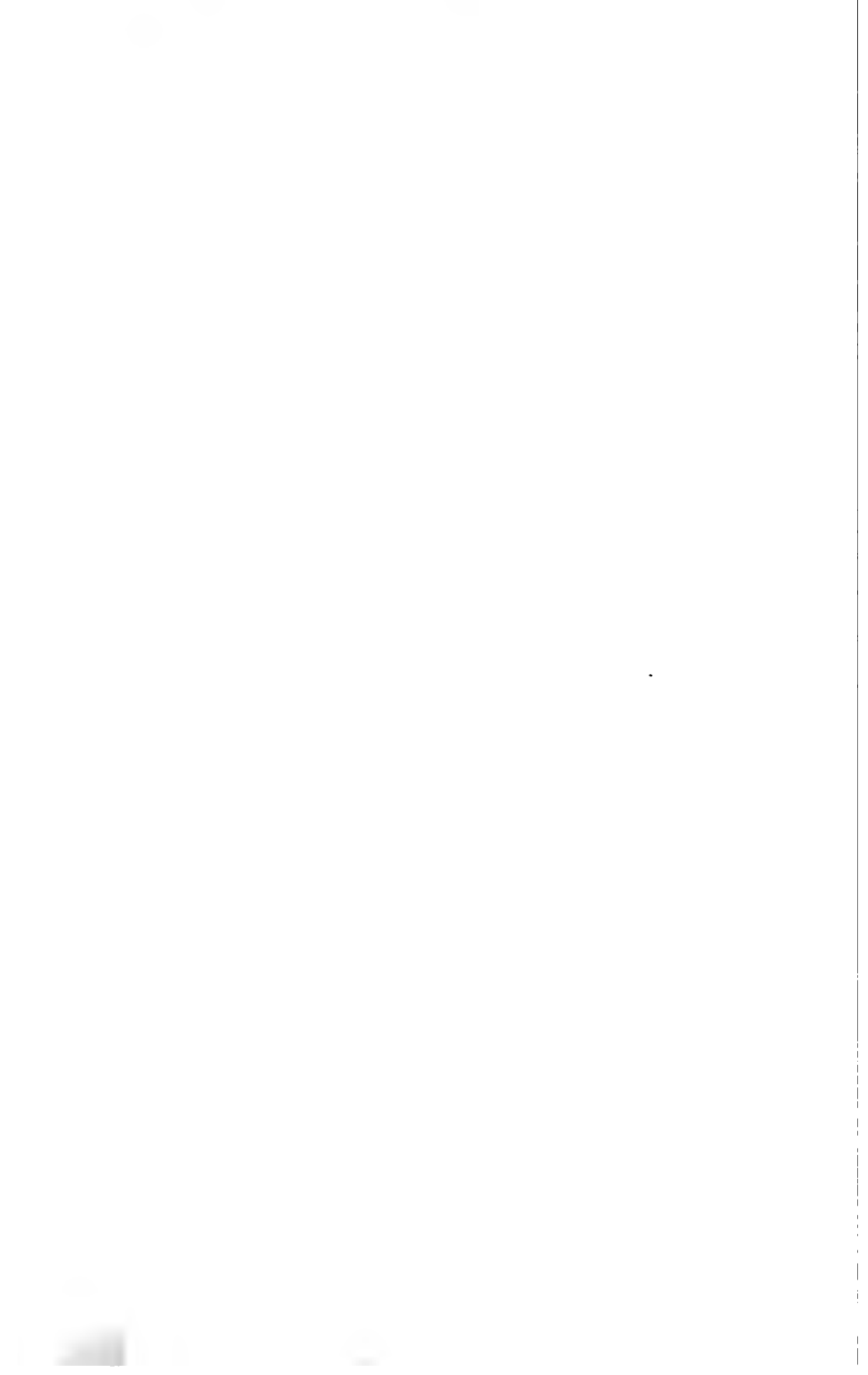
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**NATIONAL ART GALLERY**

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**CURATOR'S REPORT.**

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## APPENDIX No. 12.

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### NATIONAL ART GALLERY.

DEPARTMENT OF PUBLIC WORKS,

OTTAWA, 22nd September, 1891.

SIR,—I have the honour to report the following addition to the gallery received during the fiscal year ended 30th June, 1891 :—

Oil painting "Mortgaging the Farm," by G. A. Reid, R.C.A.

The above is a diploma picture handed over to the Government by the Royal Canadian Academy.

The number of visitors have steadily increased since the opening of Gallery. In 1883 about 8,000 persons registered their names. During the past year there have been no less than 21,289 visitors.

I have the honour to be, Sir,

Your obedient servant,

JOHN W. H. WATTS,

*Curator.*

E. F. E. ROY, Esq.,

Secretary of the Department of Public Works.

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TABLE 1. The number of stations with data for each month and the number of stations with data for each season.

Month	Number of stations	Season	Number of stations
Jan	10	Winter	10
Feb	10	Winter	10
Mar	10	Winter	10
Apr	10	Spring	10
May	10	Spring	10
Jun	10	Spring	10
Jul	10	Summer	10
Aug	10	Summer	10
Sep	10	Summer	10
Oct	10	Autumn	10
Nov	10	Autumn	10
Dec	10	Autumn	10
Winter	30		
Spring	30		
Summer	30		
Autumn	30		

TABLE 2. The number of stations with data for each month and the number of stations with data for each season.

Month	Number of stations	Season	Number of stations
Jan	10	Winter	10
Feb	10	Winter	10
Mar	10	Winter	10
Apr	10	Spring	10
May	10	Spring	10
Jun	10	Spring	10
Jul	10	Summer	10
Aug	10	Summer	10
Sep	10	Summer	10
Oct	10	Autumn	10
Nov	10	Autumn	10
Dec	10	Autumn	10
Winter	30		
Spring	30		
Summer	30		
Autumn	30		

TABLE 3. The number of stations with data for each month and the number of stations with data for each season.

Month	Number of stations	Season	Number of stations
Jan	10	Winter	10
Feb	10	Winter	10
Mar	10	Winter	10
Apr	10	Spring	10
May	10	Spring	10
Jun	10	Spring	10
Jul	10	Summer	10
Aug	10	Summer	10
Sep	10	Summer	10
Oct	10	Autumn	10
Nov	10	Autumn	10
Dec	10	Autumn	10
Winter	30		
Spring	30		
Summer	30		
Autumn	30		

TABLE 4. The number of stations with data for each month and the number of stations with data for each season.

Month	Number of stations	Season	Number of stations
Jan	10	Winter	10
Feb	10	Winter	10
Mar	10	Winter	10
Apr	10	Spring	10
May	10	Spring	10
Jun	10	Spring	10
Jul	10	Summer	10
Aug	10	Summer	10
Sep	10	Summer	10
Oct	10	Autumn	10
Nov	10	Autumn	10
Dec	10	Autumn	10
Winter	30		
Spring	30		
Summer	30		
Autumn	30		

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**APPENDIX No. 13.**

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**STATEMENT**

**SHOWING**

**NAMES, DATES OF APPOINTMENT, SALARIES, &C.,**

**OF**

**PERSONS EMPLOYED**

**ON THE DIFFERENT**

**GRAVING DOCKS,**

**30TH JUNE, 1891.**

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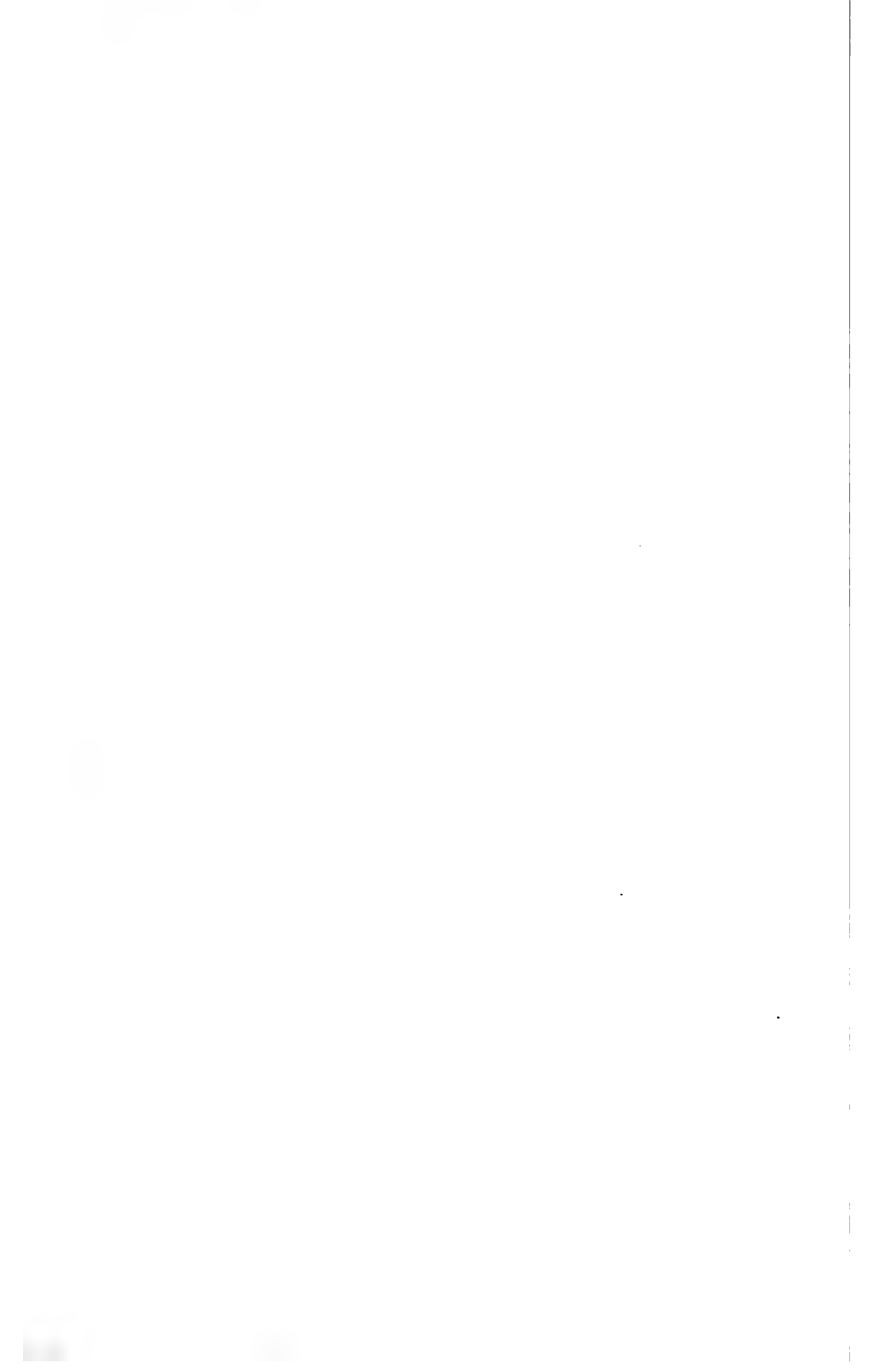


## APPENDIX No. 13.

STATEMENT Showing Names, Dates of Appointment, Salaries, &c., of persons employed on the different Traving Docks,  
30th June, 1891.

Name.	Date of Birth.	Position.	Where Employed.	Date of Appointment.	Salary.	Remarks.
<i>Esquimaux (Traving Dock, British Columbia.</i>						
John Devereux		Dockmaster.	Esquimaux.	Sept. 17, 1887.	\$166 66 per month.	
C. Muir		Engineer.	do	April 1, 1887.	100 00 do	
A. D. Greaves		Carpenter.	do	Dec. 1, 1887.	80 00 do	
F. M. Jones		Stoker.	do		60 00 do	
A. McNiven		do	do		60 00 do	
John Stock		Watchman	do		50 00 do	
<i>Lévis (Traving Dock.</i>						
Ulric Valiquette	30th June, 1856.	Dockmaster.	Lévis	April 13, 1891.	\$1,800 00 per month.	Annual allowance of \$200 for house rent. First appointment, 9th May, 1873.
Honoré Lamontagne		Dock foreman.	do	do 9, 1891.	83 33 do	
Wm. Macdougall		Mech'l engineer.	do	June 1, 1888.	75 00 do	
Napoléon Lemelin		Asst. mech'l engr'r.	do	do 1, 1888.	45 00 do	
Narcisse Lemelin		Fireman	do	do 1, 1888.	32 00 do	
Jos. Morin		do	do	April 9, 1891.	32 00 do	
Theodore Chabot		Caretaker and watchman	do	do 9, 1891.	45 00 do	\$45 per month, 1st April to 1st Dec.; \$1.25 per day, 1st Dec. to 1st April.

R. STECKEL.



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**APPENDIX No. 14.**

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**TABULAR STATEMENT**

**SHOWING THE DATES OF THE**

**OPENING AND CLOSING OF NAVIGATION**

**AT THE**

**PRINCIPAL PORTS OF CANADA,**

**ON THE SEABOARD, THE RIVER AND GULF OF ST. LAWRENCE, AND  
ON THE GREAT LAKES.**

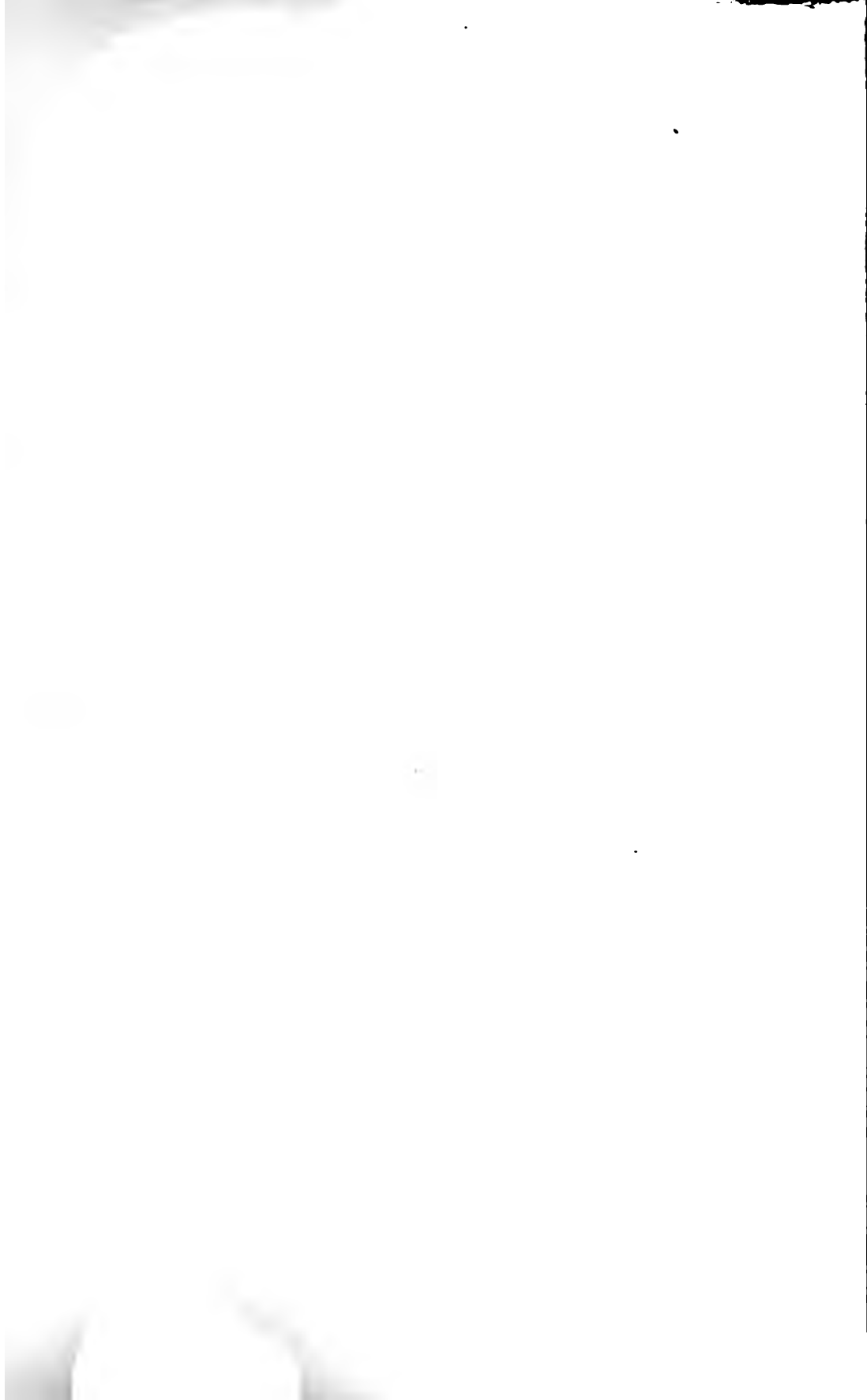
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## APPENDIX No. 14.

STATEMENT showing the Dates of the Closing and Opening of Navigation at the undermentioned Ports, in Canada, in 1890 and 1891.

Port.	Province.	Location.	Date of Closing in 1890-91.	Date of Opening in 1891.	Remarks.
Arichat, C. B.	Nova Scotia	Entrance Gulf of St. Lawrence.	Jan. 30 1891.	April 1	Never closed to navigation more than 24 months in any one year. Petit-de-Grat Inlet, which is a part of harbour, open all the year round.
Bathurst	New Brunswick.	Basin des Chaleurs.	Dec. 2	do 21	
Belleville	Ontario	Lake Ontario.	Nov. 30	do 17	
Cambridge	New Brunswick.	Basin des Chaleurs.	Dec. 1	do 23	
Charlottetown	P. E. Island.	Gulf of St. Lawrence.	do 18	do 15	
Collingwood	Ontario	Georgian Bay.	Nov. 20	do 15	
Croft	Quebec	Gulf of St. Lawrence.	Dec. 23	May 2	
Georgetown.	P. E. Island.	do	Jan. 20	March 30	The present is a fair average of dates the latter years, as there is a considerable change in favour of the port. Ice formed on harbour 17th Jan., 1891. Jan. 19, open to St. Andrew's Point; 23rd, open to railway wharf; 30th, closed to vessels other than winter boats. Ice of no thickness, the steamers making regular trips to and from Pictou and landing freight and passengers at railway wharf.
Goderich	Ontario	Lake Huron	Dec. 16	April 4	The ice was formed at earlier date, but 16th Dec. was latest vessel arrived.
Halifax	Nova Scotia.	Atlantic Ocean.			Always open and clear of ice.
Kincardine	Ontario.	Lake Huron	Nov. 16	April 22	
Kingsburg, C. B.	do	Lake Ontario.	Dec. 26	do 3	
Louisburg, C. B.	Nova Scotia.	Entrance Gulf of St. Lawrence.			Open all the year round. No ice forms in this harbour to impede navigation. Some years, in the months of March and April, the port may be blocked for one or two days with drift ice.
Montreal	Quebec.	River St. Lawrence.	Dec. 3	April 17	First arrival from sea, 30th April, 1890. Last departure for sea, 24th Nov., 1890.
North Rustico	P. E. Island.	Gulf of St. Lawrence.	Dec.	do	Last vessel cleared from this port about the last of November. Port not closed by ice until last of December or later. First vessel cleared 20th April. Ice was clear of shore about a week earlier.
North Sydney, C. B.	Nova Scotia	Entrance Gulf of St. Lawrence.	Feb. 2	do 14	On 12th April first steamer arrived. Troubled some with drift ice after that date.
Owen Sound	Ontario	Georgian Bay.	Dec. 8	do 18	
Pictou	Nova Scotia.	Gulf of St. Lawrence.	do 12	do 14	SS, "Egerton" made first trip, New Glasgow to Pictou, April 14, 1891. SS, "St. Olaf" arrived at Georgetown from Pictou April 17. SS, "St. Lawrence" arrived at Pictou from Charlottetown, 2nd April.

Port Arthur Port Huron	Ontario do	Lake Superior Lake Erie	do Nov	11 6	May April	14	These dates are taken from arrival and departure of vessels. The ice did not form until perhaps the middle of November, and navigation was really open earlier, say 8th April, 1891.
Port Hope Port Stanley	do do	Lake Ontario Lake Erie	Dec do	6 24	do March	5	
Quebec Sarnia Saint Ste. Marie Shediac	Quebec Ontario do New Brunswick	River St. Lawrence Lake Huron Lake Superior Gulf of St. Lawrence	Nov. Dec. do do	25 11 4 2	April do do do	27 25 28 23	Navigation closed about two weeks earlier than for several years past, but the opening last spring is about on an average.
Sorel St. John's	Quebec do	River Richelieu do	Nov. do	29 26	do do	20	First boat arrived from Lacolle, 2nd April, 1891. First towing steamer from Rouse's Point arrived 22nd April, 1891. Last boat out, Nov. 28, 1890. River closed with ice on the following day.
St. John Tadoussac Three Rivers Toronto	New Brunswick Quebec do Ontario	Bay of Fundy River St. Lawrence do Lake Ontario	Dec. Nov. Dec.	5 20 24	March April March	14 21	Always free from ice.
Warton	do	Georgian Bay	Nov.	30	April	23	This port was clear and open all winter.
Windsor Winnipeg	do Manitoba	Detroit River Red River	Nov.	3	April	17	Bay was lightly frozen over on the 24th Dec., but was broken up on the 25th. It was frozen again on the 28th, was partially broken up the following day and remained open until 4th January, 1891. Bay clear of ice, 17th Feb. Bay frozen over 1st March. Bay clear of ice 22nd March. First arrival, 24th March.
							Although navigation closed 30th November, ice did not form until some time in January; seldom forms till about end of January. Water bold, must be extremely cold and calm before ice forms, excepting near shore.
							Navigation was open every day during the entire season.



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**APPENDIX No. 15.**

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**R E P O R T**

**OF THE**

**COLLECTOR OF SLIDE AND BOOM DUES**

**1890-1891.**

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## APPENDIX No 15.

### COLLECTOR OF SLIDE AND BOOM DUES.

Ref. No. 37069.

DEPARTMENT OF PUBLIC WORKS OF CANADA,

CHIEF ENGINEER'S OFFICE,

OTTAWA, 2nd November, 1891.

SIR,—I transmit herewith a report by Mr. E. T. Smith, Collector of Slide and Boom Dues, Ottawa District, for the fiscal year ended 30th June, 1891.

I have the honour to be, Sir,

Your obedient servant,

LOUIS COSTE,

*Acting Chief Engineer.*

E. F. E. Roy, Esq.,  
Secretary, Public Works Department.

DEPARTMENT OF PUBLIC WORKS,

COLLECTOR'S OFFICE,

OTTAWA, 10th November, 1891.

SIR,—I have the honour of submitting my report on that branch of the service committed to my charge, namely, the collection of slide and boom dues, during the fiscal year ending 30th June last.

#### OTTAWA DISTRICT.

The revenue accrued as well as the collections have, I regret to say, both fallen off considerably during the past fiscal year as compared with the preceding year.

This deficiency is attributed to the facts that one of the largest saw mill firms in the district abandoned the saw lumber business during the year and most of the other manufacturers reduced the output of saw-logs during the winter of 1889-90; hence the number of saw-logs which passed through the Ottawa works was only 2,900,291 pieces in 1890-91, while in 1889-90 the number was 4,500,518 pieces.

The quantities of square timber which passed down the slides during the past fiscal year exceeded those of 1889-90, consequently the revenue from this source was larger by the sum of \$3,914.08.

I beg leave to explain that setting the amount of the revenue accrued during the fiscal year ended 30th June, 1890, against that of the revenue accrued during the past year would not constitute a fair comparison, as by a change in the tariff authorized by Order in Council of 30th June, 1890, the charge of one-third of one cent per saw-log for the Chaudière boom was dropped. Hence to arrive at the actual difference between the revenue of 1890-91 and that of 1889-90, there should be deducted from the latter the sum of \$6,903.05, tolls accrued at the Chaudière boom in that year, but for which work there was no charge during the year just closed. There should also be deducted the sum of \$221.02 which was written off by Order in Council, being an overcharge. These two amounts being deducted from the revenue accrued during 1889-90, the actual shortage during the past fiscal year was \$15,624.62 as compared with the previous year.

With regard to the dues outstanding uncollected at the time when the collection of the slide and boom dues was transferred to this Department (1st July, 1889) I have to state that the sum of \$2,317.84 was recovered during the past year.

Of the revenue accrued during the fiscal year ending 30th June, 1890, there remains uncollected only the amounts charged for Chaudière boomage, which are disputed.

Of the dues accrued during the past fiscal year, I have to report all collected but \$3,808.51, the particulars of which, less \$100 collected since 1st July, 1891, will be found in statement No. 4, herewith.

The total revenue accrued from the Ottawa district during the fiscal year ending 30th June, 1891, including interest was.....	\$73,794 28
Of which there was collected.....	\$69,985 77
Leaving outstanding on 30th June, 1891....	3,808 51
	<u>73,794 28</u>

The collections were as follows:—

Of dues accrued during the year 1889-91 .....	\$69,985 77
do do 1889-90.....	4,529 79
do prior to 1st July, 1889.....	2,317 84

Total amount collected and deposited in banks to credit of Receiver General .....	<u>\$76,833 40</u>
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Enclosed herewith are five statements, viz. —

No. 1—Statement of dues accrued on each of the slides and works on the Ottawa River during the year ended 30th June, 1891.

No. 2—Statement of the number of pieces of timber &c. which passed through the works during the same period.

No. 3—Statement of slide and boom dues accrued from Ottawa River works since 1st July, 1889, and received on the 30th September, 1891.

No. 4—Statement of slide and boom dues outstanding on 30th June, 1889, uncollected on 30th September, 1891.

No. 5—Statement of slide dues outstanding at Quebec 30th June, 1889, uncollected on 30th September, 1891.

#### ST. LAWENCE DISTRICT

The revenue received from the district during the year 1890-91 amounted to the sum of \$5,000.00.

The expenses of the same period were \$103.00.

The amount expended in discharging the 30th June dues was \$19,985.53 of which \$1,802.34 was paid to the Receiver General as the parties have chosen to discharge their dues to a special commissioner, the late Judge McLaughlin, who carried the duties on himself. The remainder \$1,802.34 was paid to the Receiver General. The sum of \$5,474.27 has been collected since 1st July, 1891, and received on 30th September, 1891, leaving of ordinary dues on 30th June, 1891, the sum of \$3,808.51.

No amount has been collected since the amount outstanding on the 30th September, 1891, has been paid.

#### ST. LAWENCE DISTRICT

The uncollected dues on 30th June, 1891, are shown in statement No. 7, are composed of the amounts due to the Receiver General on 30th June, 1891, and the collections since the 1st July.

Messrs. Price Bros. & Co. who owe the entire amount, \$17,235.38, have a counter claim against the Government which has not yet been dealt with.

NEWCASTLE DISTRICT.

Statement No. 8 shows in detail the amount due for slidage at Fenelon Falls, which have accumulated, in some instances, since 1877, amounting to the sum of \$6,040.20 on the 30th June last.

No dues have been received from this district since 1882, in which year the then slide master, who also acted as collector resigned; when his successor in the former capacity was appointed in the following year he was not authorized to collect the dues, therefore he simply kept a record of the quantities of timber and saw-logs which passed over the slide. The omission of instructions to him to act as collector was only discovered a short time before the collection of slide and boom dues was transferred to this department, and as the papers relating to this district were only transferred to us late in the year 1890 no steps were taken to collect these arrears until early in the present year, when accounts were sent to such of the parties who could be found and further efforts will be made to collect such of the accounts as may yet be good.

I have the honour to be, Sir,

Your obedient servant,

EDWARD T. SMITH.

*Collector of Slide and Boom Dues.*

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**No. 1.—STATEMENT showing the Dues accrued on each of the undermentioned Government Slides and Works on the River Ottawa and its tributaries during the Fiscal Year ended 30th June, 1891.**

Name of River	Name of Slide or other Improvement	Amount Accrued to each Slide.	Amount Accrued to each River.
		\$ cts	\$ cts
Ottawa	Rocher Capitaine Slide	608 00	
	Des Jonchem Slides	1,972 00	
	Calumet Slide	3,057 00	
	Portage du Fort Slide	1,986 00	
	Chabot Slide	3,445 00	
	Chambore Slide	7,390 32	
	<b>(Grand Total River)</b>	<b>6,171 32</b>	
Peterson	Slide Lake to Moose Rapids	732 95	
	New Slide near Lake Traverse	2,428 46	
	Lake Traverse, Point Lake	2,387 00	
	Slide Lake	2,224 98	
	<b>(Grand Total Peterson)</b>	<b>6,155 39</b>	
Moose Lake	Slide Lake and Highway Slides and improvements	11,138 40	
	Slide Lake and Highway Slides and improvements	3,246 47	
	Slide Lake and Highway Slides and improvements	2,224 98	
	<b>(Grand Total Moose Lake)</b>	<b>16,609 85</b>	
Moose Lake	Slide Lake	382 40	
	Slide Lake and Highway Slides and improvements	336 44	
Moose Lake	Slide Lake	1,138 40	
	Slide Lake and Highway Slides and improvements	3,246 47	
	Slide Lake and Highway Slides and improvements	2,224 98	
			<b>73,140 06</b>

**No. 2.—STATEMENT showing the Dues accrued on each of the undermentioned Government Slides and Works on the River Ottawa and its tributaries during the Fiscal Year ended 30th June, 1891.**

Moose Lake	Slide Lake	11,138 40	pieces
	Slide Lake and Highway Slides and improvements	3,246 47	do
	Slide Lake and Highway Slides and improvements	2,224 98	do
	Slide Lake and Highway Slides and improvements	3,246 47	do
	Slide Lake and Highway Slides and improvements	2,224 98	do
	Slide Lake and Highway Slides and improvements	3,246 47	do
	Slide Lake and Highway Slides and improvements	2,224 98	do
	Slide Lake and Highway Slides and improvements	3,246 47	do
	Slide Lake and Highway Slides and improvements	2,224 98	do
	Slide Lake and Highway Slides and improvements	3,246 47	do
		<b>73,140 06</b>	

**73,140 06**

No. 4.—STATEMENT of Slide and Boom Dues Accrued from Ottawa River Works since 1st July, 1889, outstanding on 30th June, 1891, and remaining uncollected on 30th September, 1891.

By Whom Due.	Year to Which Dues Belong.	Chaudière Boomage in Suspense.	Ordinary Slide and Boom Dues.	Total Dues Outstanding 1st Sept., 1890.	Remarks.
		\$ cts.	\$ cts.	\$ cts.	
J. R. Booth	1889-90	2,561 69		2,561 69	
The Bronsons & Weston Lumber Company	1889-90	2,056 96		2,056 96	
Perley & Patten	1889-90	1,203 28		1,203 28	
Pierce & Co.	1889-90	913 48		913 48	Chaudière Boomage reported to Council and referred to the Treasury Board. Should be written off.
Wm. Mason & Sons	1889-90	167 68		167 68	
do	1890-91		664 81	664 81	\$400 since paid; expect balance in a few days.
Robert Gorman	1890-91		397 50	397 50	Dues secured.
Alex. Fraser, acct. of Thos. Stephens	1890-91		28 42	28 42	Timber yet in the Ottawa River.
Hawkesbury Lumber Co.	1890-91		2,617 78	2,617 78	Chaudière Slideage—Claim for reduction in rate before the Department under consideration.
Total		6,903 05	3,708 51	10,611 56	

RECAPITULATION.

Chaudière Boomage	\$ 6,903 05
Ordinary Dues	3,708 51
	<u>\$ 10,611 56</u>

MEMORANDUM.

Amount accrued from 1st July, 1889, to 30th June, 1890.	\$ 96,542 97
do 1st July, 1890, to 30th June, 1891.	73,794 28
	<u>\$ 170,337 25</u>
Less—Amount collected and deposited during fiscal year ending 30th June, 1890.	\$ 84,889 11
Amount written off by Order in Council.	221 02
do collected and deposited during fiscal year ending 30th June, 1891.	74,515 56
do do since 30th June, 1891.	100 00
	<u>159,725 69</u>
Balance uncollected on 30th September, 1891.	<u>\$ 10,611 56</u>

EDWARD T. SMITH,  
Collector of Slide and Boom Dues.

OTTAWA, 30th September, 1891.

No. 3.—STATEMENT of Slide and Boomage from Ottawa Slides and Works outstanding 30th June, 1889, and remaining uncollected 30th September, 1891.

Name.	Bad and doubtful Debt.	Chaudière Boomage in suspense.	Other Slide and Boom Dues disputed.	Total Dues outstanding 30th Sept. 1891.	Year to which Dues belong.	Remarks.
John & Wm. McLean	53 14			53 14 1873		Insolvent.
James Yull	9 29			9 29 1876		Overcharge.
John Rowan	342 50			342 50 1872 and 1873		Insolvent.
Lenieux & Charette	21 30			21 30 1873		do
Tailon & Lapierre	148 10			148 10 1873 and 1874		do
Mosgrove & McHarry	261 42			261 42 1873 and 1874		do
W. C. Wells	600 90			600 90 1873 and 1874		do
Dufresne & McGarity	528 80			528 80 1874 and 1875		do
Walton Smith	171 46			171 46 1874 and 1875		do
A. H. Baldwin	3,507 92			3,507 92 1871 to 1874		do
Hon. James Skead	9,807 65			9,807 65 1861, 1863, 1864, 1869, 1875 to 1878		do
Batson & Currier	5,568 70			5,568 70 1875 to 1877		do
A. F. A. Knight	546 30			546 30 1878		do
James Walker	11 25			11 25 1877		do
R. Campbell & Son	1,558 50			1,558 50 1879 to 1881		do
James G. Bryson	73 50			73 50 1886		do
Costello Bros.	90 62			90 62 1882		do
N. E. Cormier	428 34			428 34 1888		do
John R. Booth		9,871 93	398 88	10,270 81 1881 to 1888		do
Perley & Pattee		8,869 85	2,456 06	11,344 91 1867, 1868, 1880 to 1888		do
The Bronsons & Weston Lumber Co.		8,180 79		8,180 79 1881 to 1885		do
Pierce & Co.		462 18		462 18 1888		do
G. A. Grier & Co.		1,060 59		1,060 59 1886 and 1887		do
Estate late L. Young		1,461 20		1,461 20 1881 to 1885		do
William Mason		413 85		413 85 1881 to 1883		do
Gilmour & Co.		406 27		406 27 1884		do
John Rochester		254 84		254 84 1881 to 1883		do
J. & B. Grier	76 84			76 84 1883		Overcharge.

\$398 88 counter claim damage by breaking of Conlonge Boom  
 \$2,035 96 counter claim damage by breaking of Madawaska Boom; \$219.10 counter claim damage of breaking of Conlonge Boom.  
 Chaudière Boomage.—These parties claim that they have maintained these works wholly at their own expense since 1881.

R. & W. Conroy	106 45	105 67 1862 and 1863.	do. Reported in return N. 38 for March, 1866.
A. & P. White	101 60	101 60 1861	Overcharge.
J. & C. Bryson	253 20	252 20 1860	Counter claim for damage by breaking of Colongue Boom.
R. Caldwell & Son	4 33	4 33 1867	Overcharge.
	253,997 28	31,000 54	4,106 14
		58,106 98	

EDWARD T. SMITH,  
*Collector of Slide and Boom Dues.*

OTTAWA, 30th September, 1891.

No. 5.—STATEMENT of Outstanding Slide Dues, Ottawa District, Bonds for which were sent to Quebec for collection, remaining unpaid 30th September, 1891.

Name.	From 1860.	From 1861.	Total.
	\$ cts.	\$ cts.	\$ cts.
Hon. James Skead.....	245 00	210 00	455 00
James Mair.....		696 75	696 75
	245 00	906 75	1,151 75

These amounts were uncollected, as the parties claimed damages for loss caused by the Madawaska Boom breaking away in 1860.

A decision on their claim was not arrived at until 2nd August, 1869; on the 5th idem Messrs. Skead and Mair were notified that the Department could not recognize their claim.

To the best of my knowledge this decision was never communicated to the Collector of Slide Dues, consequently their accounts remained in abeyance. Since then both parties died, and I believe both were insolvent at the time of their death.

EDWARD T. SMITH,

*Collector of Slide and Boom Dues.*

OTTAWA, 30th September, 1891.

No. 6.—STATEMENT of Slide and Boom Dues from the St. Maurice Slides and Works outstanding on 30th June, 1891, and remaining uncollected the 30th September, 1891.

	Year to which dues belong.	Amount.	Total.	Remarks.
		\$ cts.	\$ cts.	
George Baptist, Son & Co.	1878	489 95		Have counter claims for damages to logs caused by the booms not being stretched early enough in the spring of 1878 to permit the logs going over the Chutes. These claims were submitted to special commissioner Mr. McDougall, afterwards judge, who, after hearing the evidence on both sides, recommended that the claims of the parties should be allowed.
do do	1879	2,110 62		
do do	1880	1,696 18		
do do	1881	293 69		
do do	1882	165 80		
do do	1884	118 50		
do do	1888	4 28		
			4,859 02	
Esau, Ritchie & Co.	1878	3,072 84		
do	1883	2,173 68		
do	1884	21 96		
do	1886	1 62		
do	1887	4 38		
			5,281 48	
Alexander Baptist	1879		2,116 96	
Hall, Neilson & Co. acc't,				
Hall Bros.	1886	750 46		
do do	1887	690 44		
			1,440 90	Collector holds a bond from the Banque du Peuple for this amount.
Ross & Co	1888	624 60		
do	1889	3 06		
			627 68	Refuse to pay; give no reason that I am aware of.
Wm. Ritchie & Co.	1888	779 24		
do	1889	332 11		
			1,111 35	Of this amount \$754.20 is claimed to be an over-charge.
Ritchie Bros.	1886	413 43		
do	1887	634 71		
			1,048 14	This amount is composed of overcharges in 1886 and 1887 of \$842.76, and overpayments in 1884 of \$205.38.
I. A. Gagnon	1890		124 32	I know of no reason why these amounts have not been paid.
G. R. Hall	1890		49 34	
T. E. Normand	1890		42 83	
Total			16,702 02	

OTTAWA, 30th September, 1891.

EDWARD T. SMITH,  
*Collector of Slide and Boom Dues.*

No. 7.—SAGUENAY DISTRICT—Statement of Slide Dues accrued at the Saguenay outstanding on the 30th June, 1891, unpaid 30th September, 1891.

Name.	Year to which Dues belong.	Amount.
		\$ cts.
Messrs. Price Bros. & Co.	1877 to 1890.	17,235 38

OTTAWA, 30th September, 1891.

EDWARD T. SMITH,  
*Collector of Slide and Boom Dues.*

No. 1.—CONTRACTS let by the Department of Public Works, &c.—Continued.

[illegible]

## No. 1.—CONTRACTS let by the Department of Public Works, &amp;c.—Continued.

Works.	Names of Contractors.	Date of Contract.	Amount.
PUBLIC BUILDINGS—Continued.			\$ cts.
Quebec—Concluded.			
Montreal Examining Warehouse—Supply of coal.	F. Robertson.	Aug. 29, 1890	1,740 00
Quebec Public Buildings and Citadel do	Madden & Ellis.	do 21, 1890	3,074 30
Sherbrooke Post Office Building do	Lucke & Mitchell.	Sept. 17, 1890	271 30
do do	H. C. Charland & Co.	do 16, 1890	271 00
St. Henri Post Office—Erection.	Frigon & Peltier.	Oct. 13, 1890	7,770 00
St. Hyacinthe Post Office—Erection.	Lortie & Naud.	July 19, 1890	12,860 00
St. Jerome Post Office Building—Supply of coal.	Dufresne & Mongenais.	Sept. 30, 1890	384 63
St. John's do	Bissett & Donaghy.	Aug. 30, 1890	168 00
Three Rivers Custom House and Post Office—Supply of coal.	Z. Marchand.	do 28, 1890	581 49
Valleyfield Post Office—Alterations and repairs.	Bélanger & Préfontaine	(Sept. 26, '90) (Oct. 20, '90)	250 00
Ontario.			
Amonte Public Building—Heating apparatus.	Dunlop & Chapman.	Nov. 19, 1890	875 00
do Laying pipes for water service.	R. Cameron.	June 18, 1891	365 00
do Interior fittings and porch.	R. Cameron.	Nov. 10, 1890	1,560 00
do Supplying the water.	Young Bros.	June 18, 1891	75 00
Amherstburg Public Building—Supply of coal.	Mullen & Co.	Aug. 29, 1890	180 00
Barrie Post Office Building—Supply of coal.	Johnson & Sarjeant.	do 28, 1890	230 00
Belleville do	The Downey Co.	do 29, 1890	345 00
Berlin do	J. Fennell.	do 28, 1890	181 50
Brampton do	J. Ryan.	do 9, 1890	148 50
do do Incandescent lighting.	J. O. Hutton.	July 11, 1890	30 00
Brantford do Water supply.	Water Commissioners of Brantford.	Nov. 8, 1890	38 00
do do Supply of coal.	T. Elliott.	Aug. 28, 1890	238 16
Brockville do	Geo. E. Shields.	Sept. 10, 1890	119 00
do do	W. T. McCullough.	do 10, 1890	135 50
Carleton Place Post Office—Erection.	R. Cameron.	Dec. 9, 1890	12,039 00
Cayuga Post Office—Supply of coal.	T. Martindale.	Aug. 30, 1890	143 75
Chatham Post Office Building—Supply of coal.	J. L. Scott.	do 30, 1890	111 18
Clifton do	Coulson & Robinson.	do 28, 1890	258 75
Cobourg do	Hargraff & Co.	Oct. 9, 1890	236 00
Cornwall do	Flack Bros.	Sept. 18, 1890	230 00
Caledonia do	Perry & Co.	Aug. 29, 1890	171 00
Cananogue Custom House and Post Office—Supply of coal.	The Rathbun Co.	Sept. 2, 1890	194 75
Coderich Post Office Building—Supply of coal.	Wm. Lee.	Oct. 13, 1890	210 00
Geoff do	Kloepfer & Co.	Sept. 26, 1890	170 84
Hamilton do	Æ. D. Mackay's Sons.	Aug. 29, 1890	936 00
Kingston—Public Buildings	W. B. & S. Auglin.	do 28, 1890	216 00
Lindsay Post Office Building	The Rathbun Co.	Sept. 2, 1890	93 36
London Custom House and Post Office—Supply of coal.	D. Daly & Son.	do 1, 1890	840 00
London Post Office—Renewing pipes to heating apparatus.	Smith Bros.	July 12, 1890	105 00
Napanee Public Building—Water Service—Connections.	Napanee Water Works Co.	Aug. 28, 1890	80 00
Napanee Public Building—Water Service—Supply of water.	Napanee Water Works Co.	do 28, 1890	79 30
Napanee Public Building—Supply of coal.	The Rathbun Co.	Sept. 2, 1890	133 75
Orangeville Post Office Building—Supply of coal.	J. Morrison.	do 1, 1890	134 50
Ottawa Post Office—Incandescent lighting—Installation—For the supply of current, per light, per hour, 1 cent.	Chaudière Electric Light and Power Co.	Aug. 5, 1890	373 00
Ottawa—Major's Hill Park—Maintenance.	L. Garello.	Sept. 19, 1890	3,700 00
do Supreme Court Building—Addition.	W. Stuart.	Oct. 28, 1890	10,765 00

### No. 1.—CONTRACTS let by the Department of Public Works—Continued.

[illegible]

## No. 1.—CONTRACTS let by the Department of Public Works—Continued.

Works.	Names of Contractors.	Date of Contract.	Amount.
<b>HARBOURS AND RIVERS—Continued.</b>			
<i>Nova Scotia—Concluded</i>			\$ cts.
Great Village—Public wharf.....	A. McKinnon .....	Jan. 19, 1891	1,940 00
Stony Island—Breakwater.....	J. Nicholson.....	Oct. 20, 1890	4,650 00
Tidnish River—Public wharf.....	D. Sutherland.....	July 4, 1890	1,900 00
Walton Harbour—Breakwater.....	McDonald & Moffatt.....	Dec. 23, 1890	6,170 00
<i>Prince Edward Island.</i>			
Brace Harbour—Extension to breakwater.....	H. McPhee.....	April 16, 1891	850 00
Port Setkirk—Block and span to pier.....	F. & F. Panting.....	Feb. 25, 1891	600 00
do Reconstruction and strengthening lower end of pier.....	Wightman & T. Mellish.....	May 9, 1891	1,550 00
<i>New Brunswick.</i>			
Campbellton—Ferry wharf.....	J. Filion.....	Mar. 31, 1891	2,800 00
Caraquet Harbour—Public landing.....	H. Thérian.....	Oct. 25, 1890	1,000 00
Gray's Island—Breakwater.....	J. McFarlane.....	do 27, 1890	5,483 00
Negro Point (St. John Harbour)—Repairs to breakwater.....	A. McKinnon.....	Jan. 19, 1891	2 20 per c. yd.
<i>Quebec.</i>			
Ste. Anne des Monts—Isolated block.....	A. J. Andrews.....	Nov. 4, 1890	8,898 00
<i>Ontario.</i>			
Beaverton—Landing pier.....	D. Porter.....	Feb. 9, 1891	7,500 00
Belleville—Dredging in the harbour.....	Weddell Bridge and Engine Works.....	Sept. 9, 1890	14c. p. c. yd.
Kaministiquia River—Dredging.....	J. Murray.....	Aug. 9, 1890	Sched. rates.
Kingston Dry Dock—Pumping plant.....	J. Inglis & Son.....	Dec. 4, 1890	23,300 00
do Wrought iron caisson.....	Dom. Bridge Co., Ltd. do	24, 1890	17,782 97
Warton—Extension of breakwater.....	D. Porter.....	July 16, 1890	5,900 00
York Village—Abutments and piers of a bridge intended to be built across Grand River at.....	Burns & Laughran.....	Oct. 13, 1890	6,450 00
York Village—Iron superstructure of above bridge.....	Dom. Bridge Co., Ltd. Dec.	24, 1890	8,800 00
<i>North-West Territories.</i>			
Macleod—Old Man's River bridge.....	Smith & Heney.....	April 10, 1891	25,640 00
<i>British Columbia.</i>			
Esquimalt Graving Dock—Steel stop-gate for caisson recess.....	Albion Iron Works Co. Mar.	2, 1891	5,976 25
<b>DREDGE VESSELS AND PLANT.</b>			
Alberton, P.E.I.—Crane and circle for dredge "Prince Edward".....	J. P. Cunningham.....	May 21, 1891	449 24
Hull, Que.—Hull for dredge "St. Louis".....	P. G. Waters.....	Feb. 23, 1891	1,500 00
River St. John, N.S.—Three centre dumping scows.....	McLeod & Kitchin.....	Mar. 10, 1891	4,495 00
Victoria, B.C.—Three hopper dredge scows.....	O. Warner.....	Feb. 25, 1891	4,650 00
<b>TELEGRAPH LINES SERVICE.</b>			
Supply and distribution of poles for Government telegraph line between Broad Cove and Meat Cove.....	W. Hellen.....	Feb. 16, 1891	70c. per pole.

F. X. R. SAUCIER.

DEPARTMENT OF PUBLIC WORKS,  
OTTAWA, 12th October, 1891.

Report of the Department of Public Works during the Fiscal Year ended 30th June, 1891.

Description of Property	For what Purpose	Area	Price
1. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
2. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
3. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
4. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
5. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
6. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
7. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
8. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
9. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
10. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
11. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
12. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
13. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
14. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
15. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
16. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00
17. 1000 sq. ft. of land at the corner of the intersection of the main road and the main road, for public building.	Public building	200 x 114 ft., 2 in	\$ 2,000 00

Report of the Department of Public Works, Ottawa, 12th October, 1891.

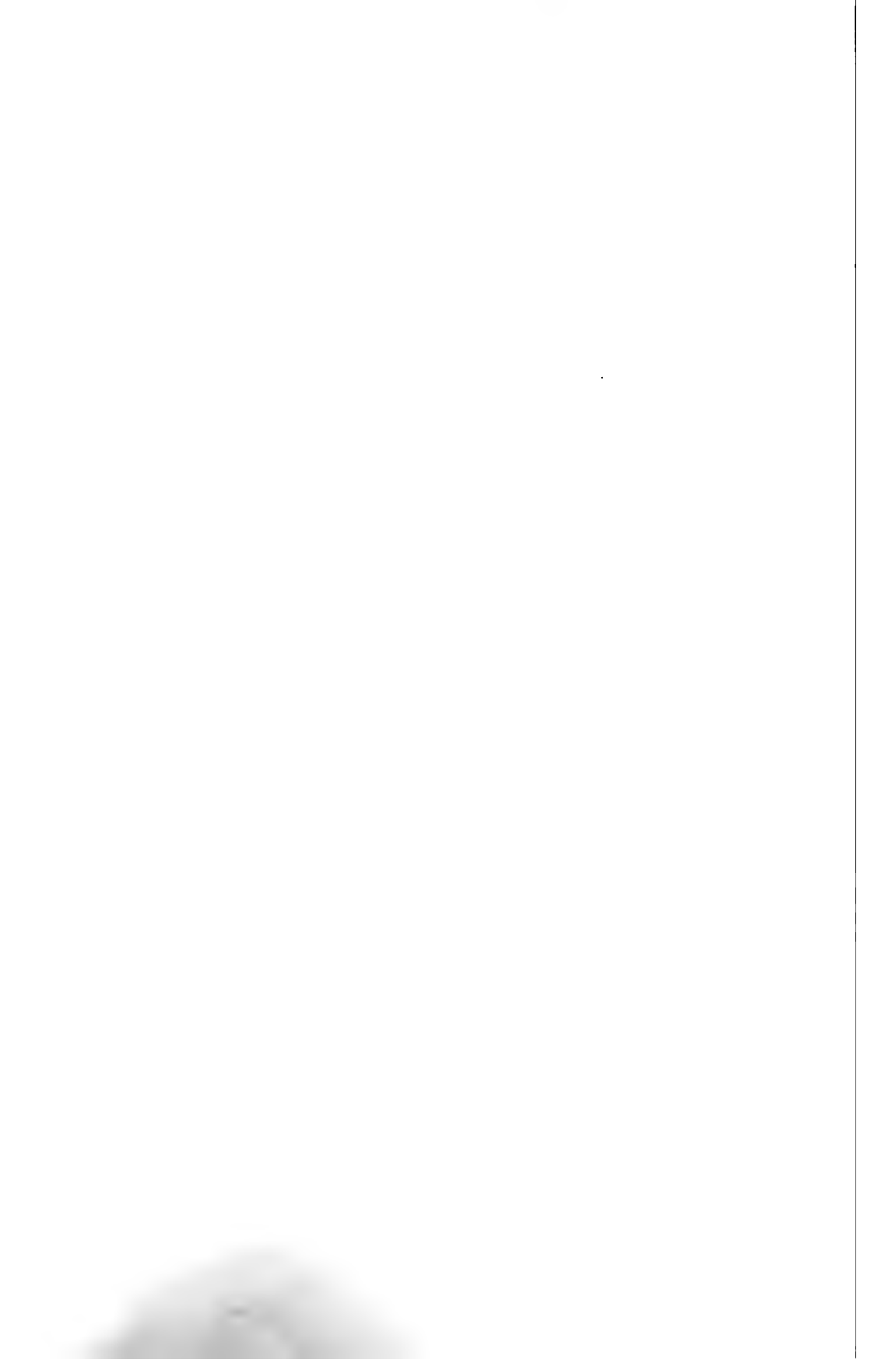
F. X. R. SAUCIER.

511, II.—STATEMENT of Property leased to and by the Department of Public Works during the Fiscal Year ended 30th June, 1891.

Date of Lease.	Lessor.	Lessee.	Property Leased.	For what Purpose.	Duration of Lease.	Rent Payable per Annum.
July 24, 1890.	Her Majesty.	Wm. Dodd.	Old Government House at Yale, B.C.	Personal use and maintenance.	3 years.	\$ sta. 1 00
Sept. 4, 1890.	H. Paymont.	Her Majesty.	A wooden building at Valleyfield, Que.	Post office.	3 do.	300 00
May 12, 1891.	Her Majesty.	J. R. Booth.	Part of "Toll Gate Reserve" at Union Bridge, Ottawa.	Milling purposes.	21 do.	150 00

F. X. R. SAUCIER.

DEPARTMENT OF PUBLIC WORKS,  
OTTAWA, 12th October, 1891.



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**APPENDIX No. 18.**

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**R E P O R T**

**ON THE**

**ST. MAURICE DISTRICT SLIDES AND BOOMS**

**FOR THE FISCAL YEAR ENDED 30TH JUNE, 1891.**

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## APPENDIX No. 18.

### SLIDES AND BOOMS, ST. MAURICE DISTRICT.

Ref. No. 35360.

CHIEF ENGINEER'S OFFICE,  
OTTAWA, 4th July, 1891.

SIR,—I transmit herewith a report by Mr. C. Lajoie, Superintendent of the St. Maurice District Slides and Booms, on the works under his charge, for the fiscal year ended 30th June, 1891.

I have the honour to be, Sir,  
Your obedient servant,  
**HENRY F. PERLEY,**  
*Chief Engineer.*

E. F. E. Roy, Esq.,  
Secretary, Department of Public Works,  
Ottawa.

OFFICE OF THE ST. MAURICE WORKS,  
THREE RIVERS, 3rd July, 1891.

SIR,—I have the honour to transmit, for the information of the Honourable the Minister of Public Works, my annual report of works done on the St. Maurice under my supervision, for the past fiscal year ended 30th June last.

There have been no accidents on the works and the drive was well made. The number of logs cut last winter will amount to, I am informed, 300,000; all of which will reach their destination, excepting some 30,000 that cannot pass down before next spring.

Appropriation for maintenance.....	\$16,600 00
do repairs .....	5,800 00
Expenses of maintenance.....	16,718 53
do repairs .....	3,987 41

Details of expenditure herewith annexed.

I have the honour to be, Sir,  
Your obedient servant,  
**CHARLES LAJOIE,**  
*Superintendent.*

**HENRY F. PERLEY, Esq.,**  
Chief Engineer, Public Works,  
Ottawa.

Details of repairs executed as follows :—

#### *Entrance of the St. Maurice.*

1. Six pieces of boom strengthened with 11 by 17-inch spruce; 1,500 lbs. of iron bolts.
2. Seven pieces of boom, 30 feet long by 32 inches by 16 inches thickness, spruce.
3. 765 lbs. of iron tie bolts.

*Cap aux Corneilles.*

1. Five pieces of boom, 150 feet long by 5 feet, sheeted with 3-inch plank.
2. 1,000 lbs. of 7 by  $\frac{3}{4}$  inch nails.
3. Repairing 2,000 feet of old doubled booms.

*Shawenegan.*

1. Sheeting 1,081 feet of boom  $3\frac{1}{2}$  feet wide, with 3-inch planking of spruce and hemlock.
2. Repairs to Grand Remous wharf at the foot of the falls, 14 pieces of sheeting of 10 feet and 8 inches in thickness and other minor and indispensable repairs.
3. Reconstructing pier No. 7 in the retaining boom, 33 feet long, 21 feet wide and 30 feet high.
4. Construction of a wharf 67 feet long, 8 feet high; to protect blacksmith shop against eroding of the hill which takes place every spring.
5. Repairing 121 feet of doubled boom, making 6 feet in width, with 3-inch cross-ties every 10 feet.

*Grand Mere.*

1. Two pieces of boom 150 feet long by 3 feet wide, covered with 3-inch planking; three kegs of nails.
2. Repairing a small wharf, at the foot of the falls, 12 feet square.
3. Building two barges, one 32 feet and the other 22 feet.
4. Covering 225 feet of boom with 3-inch plank; 6 kegs of 6-inch nails.
5. Two anchors, one of 1 500 lbs. and the other 3,000 lbs.
6. 1,500 feet of chain of  $\frac{3}{4}$  and  $\frac{7}{8}$  inches.
7. Repairs to a scow.

*Grandes Piles.*

1. Repairs to pier No. 1; 2 pieces of elm cap timbers, 20 feet by 18 inches; 4 pieces, 20 feet by 12 inches square; 150 lbs.  $\frac{3}{4}$ -inch iron, 3-inch sheeting and 2 $\frac{1}{2}$  kegs of 6-inch spikes.
2. Repairs to pier No. 2; 2 elm cap timbers, 20 feet by 18 inches; 4 pieces 20 feet by 12 inches square; 150 lbs.  $\frac{3}{4}$ -inch iron.
3. Repairs to pier No. 3; face sheeting on three sides with 3-inch plank; 4 kegs of 6-inch nails; 4 cap-timbers, 20 feet of 12 inches by 12 inches.
4. Repairs to pier No. 4: sheeted on three sides with 3-inch planks; 4 kegs of 6-inch nails; 4 cap timbers, 30 feet of 12 inches by 12 inches.
5. 10 toises of stone to fill in wharves.
6. To complete repairs to station house; build and paint a ceiling, 36 by 24 feet; plastering upper part of house and framing 3 doors and 3 windows; build and paint a ceiling in kitchen, 18 by 18 feet; plastering and framing of 3 doors and 3 windows; also, a large cupboard.
7. Repairs to two pieces of boom of 150 feet, sheeted with 3-inch plank; 4 kegs of nails.

Amount of expenditure for maintenance and repairs for fiscal year ended 30th June, 1891:

Appropriation for repairs.....	\$ 5,800 00	
Expenditure do .....	3,987 41	
Balance unexpended.....		\$1,812 59
Expenses for maintenance:—		
Appropriation for maintenance.....	\$16,600 00	
Expenses do .....	16,718 53	
Over-expenditure.....		118 53
Unexpended surplus of both appropriations....		<u>1,694 06</u>

THREE RIVERS, 3rd July, 1891.

CHARLES LAJOIE,  
Superintendent.

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APPENDIX No. 19.

—  
REPORT

ON THE

# SAGUENAY SLIDE

FOR THE FISCAL YEAR ENDED 30TH JUNE, 1891.

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## APPENDIX No. 19.

## SAGUENAY SLIDE.

CHIEF ENGINEER'S OFFICE,  
OTTAWA, 29th March, 1892.

SIR,—I transmit herewith a report by Mr. Joseph Rosa, Assistant Engineer on the Saguenay Slide, for the fiscal year ended 30th June, 1891.

I have the honour to be, Sir,

Your obedient servant,

LOUIS COSTE,  
*Acting Chief Engineer.*

E. F. E. ROY, Esq.,  
Secretary, Department of Public Works,  
Ottawa.

QUEBEC, 3rd August, 1891.

SIR,—I have to report as follows on the works executed at the Saguenay Slide, for the fiscal year ended 30th June, 1891.

The mooring pier, to which is attached the head of the main boom, was taken down and rebuilt, and repairs were made to the slide and the booms, and dam No. 7 was strengthened.

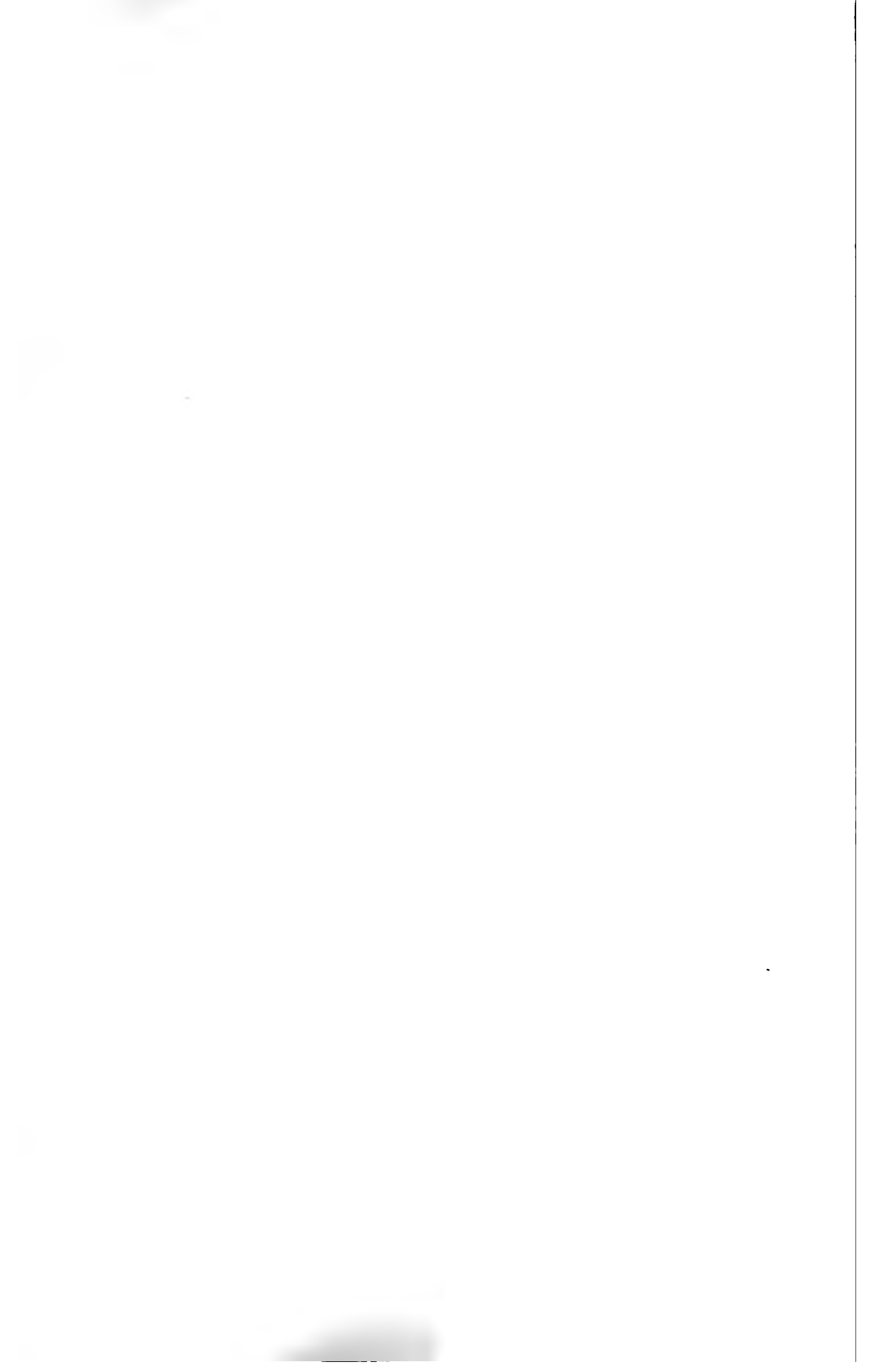
The number of logs of different dimensions which passed through the slide during the year was 79,100.

I have the honour to be, Sir,

Your obedient servant,

JOSEPH ROSA,  
*Superintendent.*

The Acting Chief Engineer,  
Public Works Department,  
Ottawa.



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**APPENDIX No. 20.**

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**L I S T**

**OF SOME OF THE**

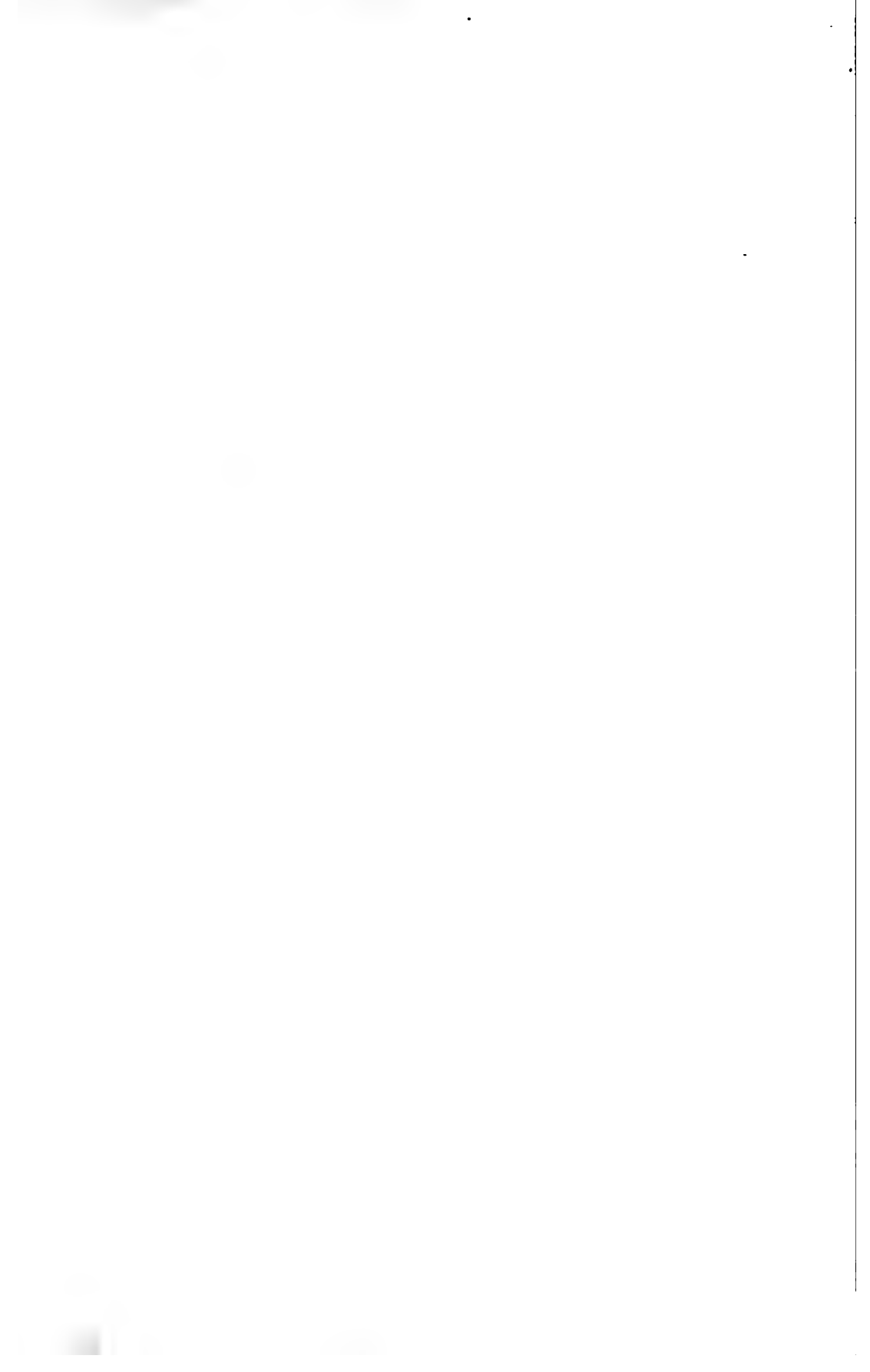
**ACTS OF PARLIAMENT PASSED AT THE SESSION OF 1891**

**AND HAVING REFERENCE TO THE**

**DEPARTMENT OF PUBLIC WORKS**

**OR WORKS UNDER ITS CHARGE.**

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## APPENDIX No. 20.

**LIST of some of the Acts passed at the First Session of the Seventh Parliament of Canada, prorogued on the 30th day of September, 1891, and having reference to the Department of Public Works, or Works under its charge.**

Subject.	Full Title of the Statute.	Chapter.	Page in Statute Book.
<b>Sums granted to Her Majesty for the financial year ending 30th June, 1892, and the purposes for which they are granted.</b>	An Act for granting to Her Majesty certain sums of money required for defraying certain expenses of the public service, for the financial years ending respectively the 30th June, 1891, and the 30th June, 1892, and for other purposes relating to the public service. (Assented to 10th July, 1891.)	1	3
do. do.	An Act for granting to Her Majesty certain sums of money required for defraying certain expenses of the public service for the financial year ending the 30th June, 1892, and for other purposes relating to the public service. (Assented to 28th August, 1891.)	2	37
<b>Transfer of certain Public Property to the Provincial Governments.</b>	An Act authorizing the transfer of certain Public Property to the Provincial Governments.	7	84
<b>Frauds upon the Government.</b>	An Act respecting Frauds upon the Government.	23	139
<b>In amendment of the Act respecting Government Harbours, Piers and Breakwaters.</b>	An Act to amend the Act respecting Government Harbours, Piers and Breakwaters.	52	214

F. X. R. SAUCIER.

DEPARTMENT OF PUBLIC WORKS,  
OTTAWA, 29th March, 1892.



CANADA

ANNUAL REPORT

MINISTER OF PUBLIC WORKS

FOR THE FISCAL YEAR 1890-91

PART II

WATER LEVELS, RIVER ST. LAWRENCE

Survey

QUEBEC AND MONTREAL.

REPORT BY A SURVEYOR ENGINEER IN CHARGE OF LEVELLING AND  
HAULING OPERATIONS. TRANSMITTED BY L. COMTE,  
ACTING DEPUTY MINISTER OF PUBLIC WORKS, 1891

PRINTED AT THE QUEBEC PRESS



QUEBEC,  
PRINTED BY J. B. LEBLANC, PRINTER TO THE QUEBEC BOARD  
OF TRADE AND COMMERCE.



CANADA

ANNUAL REPORT

MINISTER OF PUBLIC WORKS

FOR THE FISCAL YEAR 1890-91

PART II.

WATER LEVELS, RIVER ST. LAWRENCE

BETWEEN

QUEBEC AND MONTREAL.

REPORT BY R. STECKEL, ENGINEER IN CHARGE OF LEVELLING AND  
GAUGING OPERATIONS, ETC.. TRANSMITTED BY L. OOSTE,  
ACTING CHIEF ENGINEER OF PUBLIC WORKS, 1891.

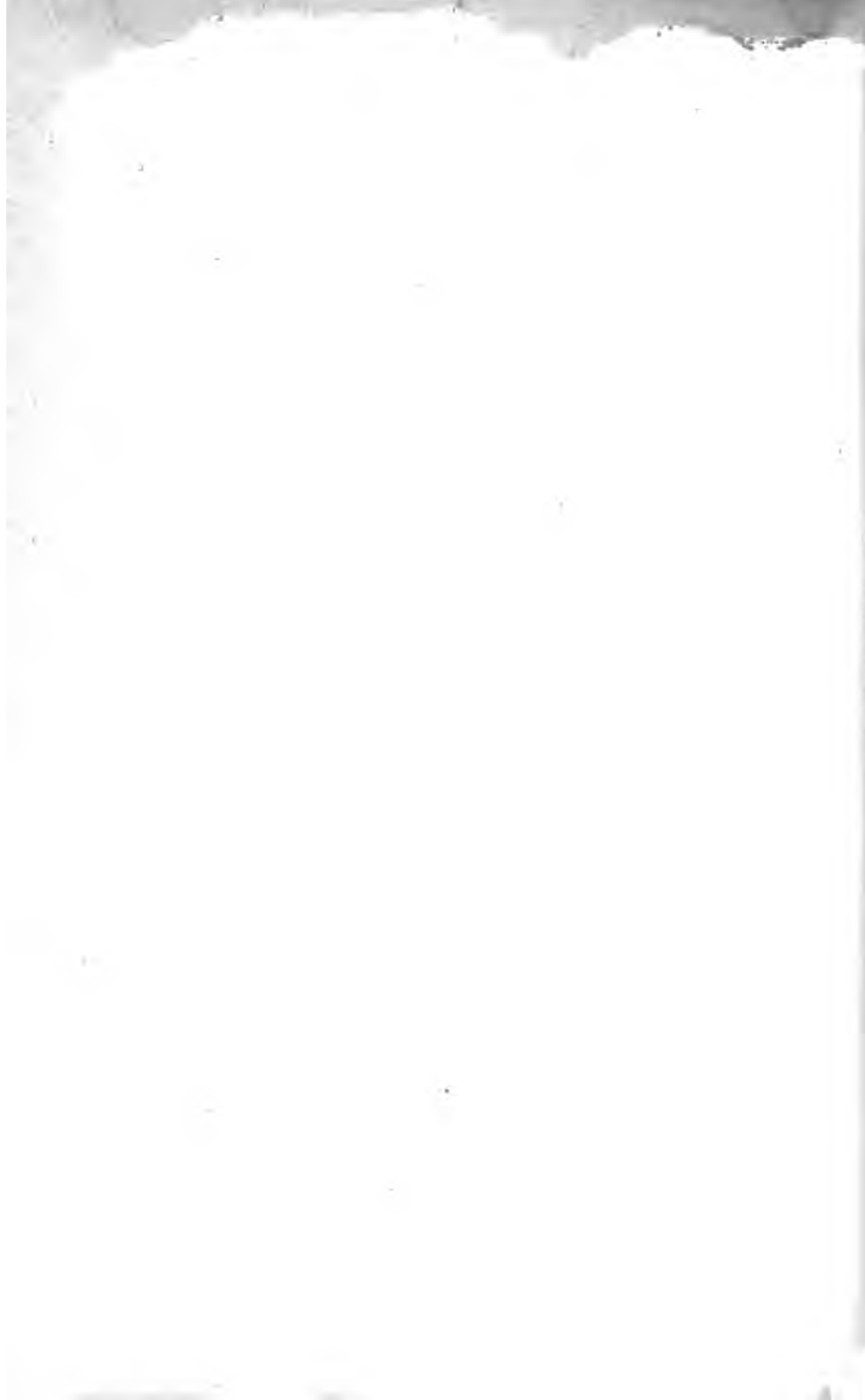
PRINTED BY ORDER OF PARLIAMENT



OTTAWA

PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST  
EXCELLENT MAJESTY.

1893



DEPARTMENT OF PUBLIC WORKS OF CANADA,

CHIEF ENGINEER'S OFFICE,

OTTAWA, 2nd December, 1891.

SIR,—I have the honour to transmit herewith the report of Mr. R. Steckel, of this department, in connection with the determination of water levels along the River St. Lawrence by geodetic levelling, between the cities of Montreal and Quebec.

The work done by Mr. Steckel, and the results attained thereon are, in my opinion, of such interest and importance, that I have no hesitation in recommending that his report be printed as an appendice to the Honourable the Minister's report.

The field work performed, including tide and river gauging as well as levelling operations, was commenced in 1885 and completed in 1888; the total length of time spent in the field being about 14 months. The office work, which was of a very laborious nature, had to be performed by Mr. Steckel and his assistants so as to interfere as little as possible with his departmental duties, and the proficiency with which it has been done is deserving of the highest praise.

Three special appropriations were made by Parliament for this work: \$3,000 in 1886-87, \$2,500 in 1887-88, and \$2,500 in 1888-89, in all \$8,000, but this amount does not represent the total cost of the work performed in the field and in the office, as the technical part of the work was done chiefly by employees of the department under Mr. Steckel's superintendence.

This was considered the most satisfactory and most economical way of doing this work, and the results attained give, without doubt, a fair return for the outlay incurred.

Before closing my remarks on this Report, I would take the liberty of strongly advising that this work of establishing geodetic bench-marks along the River St. Lawrence be continued: 1st. Easterly from Quebec to the Atlantic coast, and westwardly from Montreal to the great lakes, and up the Ottawa River. Such a general system of accurate levels would prove of immense value for public works of all kinds, as well as for agricultural, hydrological and geological researches, and would be more especially useful to the Departments of Public Works and Marine, under whose dual control the navigation of the whole of the St. Lawrence is vested.

The work below Quebec would be of great service, in connection with the projected determination of the low water plane to which soundings should be properly reduced in the "Beaujeu Channel," previous to engaging in expensive sounding operations with the object of ascertaining the cost of removing the obstructions at the upper end of that channel, which are represented by the Marine Department as a source of danger to seagoing vessels of over 25 feet draught.

However, pending the completion of the eastern section of the projected work along the St. Lawrence between Quebec and the Atlantic coast, which should be the first undertaken—and the determination of the correct mean sea level at some point on the gulf shore, by the Marine Department, by means of an extended series of tidal observations, towards which Parliament has voted the sum of \$10,000 at its session of 1891.

the result of the levelling operations so far obtained between the cities of Montreal and Quebec could be issued in pamphlet form for the use of engineers, surveyors, etc., the present approximate mean sea level datum being provisionally retained.

Of the 28 illustrations (plans, diagrams and charts) transmitted with Mr. Steckel's report, only 15 need, strictly speaking, be reproduced by lithography to render the report intelligible. These are Nos. I to VI and Nos. IX, XI, XIV, XV, XIX, XXIII, each on one sheet; also Nos. XXVI and XXVII, each as a whole or in two parts, and No. XXVIII, on one sheet.

As regards the appendices, Nos. 13, 14, 15, 16, 17, 18, 19, 20, 21 should be published.

I have the honour to be, sir,

Your obedient servant,

LOUIS COSTE,

*Acting Chief Engineer.*

E. F. E. Roy,

Secretary, Department of Public Works.

# WATER LEVELS, RIVER ST. LAWRENCE,

BETWEEN

## QUEBEC, MONTREAL AND LACHINE.

DEPARTMENT OF PUBLIC WORKS,

OTTAWA, 24th November, 1891.

The Chief Engineer of Public Works.

SIR,—I have the honour to submit the following report on the levelling and gauging operations which have been carried out under my direction between Quebec and Montreal, as per instructions received from you, with a view of determining the water levels of the St. Lawrence above the mean level of the sea during high and low stages of the river, for various phases of characteristic fluvial tide waves and establishing reliable permanent bench marks along this, the principal Canadian highway of navigation, for use in connection with the ship channel and other harbour and river works.

The levelling performed between Sorel and Quebec forms the second link of the projected circuit of precision levels, from the tide-gauging station which has been established by the United States Coast and Geodetic Survey, on the Atlantic Ocean at Governor's Island,\* Harbour of New York, back to the same ocean in the Gulf of St. Lawrence, via the Hudson River, the Champlain Canal, Lake Champlain, the River Richelieu and the River St. Lawrence. It appears from the accompanying "Extract" from a report dated 10th October, 1887, on fluctuations in the level of Lake Champlain and the average height of its surface above the sea, by assistant C. A. Schott † (see Appendix No. 14), that in the United States, the spirit levelling commenced in 1857-58 at New York, has lately been completed up to Putnam station on the Delaware and Hudson Canal Company's Railway near the head of Lake Champlain, and that from the station just named the elevation of the lake was transferred by water level to Rouse's Point, at the foot of the said lake.

The precision levelling commenced on Canadian territory, in 1883-84 near Rouse's Point, is now completed inclusive of office computation: 1st, along the River Richelieu from the named village to the town of Sorel; 2nd, along the St. Lawrence between the city of Quebec and the town of Lachine.

The system of simultaneous double levelling and the methods of observation and station adopted for the work performed along the River Richelieu between Lake Champlain and the St. Lawrence, and which are fully described in the report addressed under date of 16th September 1885, ‡ I have continued to follow in all essential particulars between Quebec and Montreal. Moreover, geodesic level No. 1 and improved rods C, D, illustrated and described in detail in the said report, were again made use of in addition to these instruments a second level, No. 2, constructed by the same makers as No. 1, M. M. Fauth & Co., of Washington, D.C., was brought into position when wide streams had to be crossed, and also the two new rods E and F and accessories constructed by the late Mr. E. Chanteloup of Montreal, which were exhibited at the London Indian and Colonial Exhibition of 1886.

The absolute heights of the great lakes are referred to the mean sea level deduced from gaugings made at Rouse's Island, 1852 to 1879.

This report was transmitted to this department 11th May, 1888, by B. A. Colonna, Esq., assistant in charge of the Survey Office at Washington, in reply to a request made at my suggestion (see No. 77573, 1887), for the heights of some prominent bench marks in the vicinity of Rouse's Point, or in any locality near the frontier easily accessible from the Canadian side—above the mean level of the sea obtained at one of the tide-gauging stations established by the survey on the Atlantic coast.

This report is published inclusive of illustrations in the official report of the Department of Public Works for the fiscal year 1884-85, as Appendix No. 7.

The new pivot level No. 2 had also to be used for a short time at Montreal and vicinity on the north shore of the St. Lawrence, while repairs were being made to level No. 1.

This instrument (No. 2) carries a horizontal circle five inches in diameter, which permits of reading angles to thirty seconds instead of single minutes only as in No. 1. mean value of one level division, 2 millimetres long = 3.3 seconds; one division of micrometer head, keyed on screw for raising or depressing telescope and level, corresponds to 2.22 seconds. Aperture of telescope = 0.124 feet; focal distance of object lens = 1.34 foot.

It is provided with two astronomical eye pieces which afford magnifying powers of about 40 and 60 diameters, in connection with the objective of the telescope.

The angular distances from the horizontal wire in the optical axis of the telescope, to the stadia wires on either side are: 2' 25".5 and 4' 29".5; the angle between the extreme wires being therefore 6' 55."

Inclination due to inequality of collars =  $\frac{1}{10}$  of a micrometer division or 0.2 second: the eye end collar being smaller than that at the object end of the telescope, for which reason the correction required according to distance had to be added to each reading.

#### LEVELLING OPERATIONS PERFORMED.

Two continuous lines of levels, marked A and B on the computation sheets and abstracts, were run simultaneously on the south shore of the St. Lawrence between Caughnawaga and the graving dock at St. Joseph de Lévis, viz., in seven sections of from about 25 to 35 miles in length, numbered from 4 to 10; the levelling operations being carried on in opposite directions on alternate sections, as was done along the River Richelieu, with a view of preventing in a measure, the gradual accumulation of error supposed to arise from working constantly in the same direction.

The sections of the continuous line, together with the cross-sections, check lines, loop lines, &c., levelled in connection with the same, are indicated approximately in red on Admiralty charts Nos. 2830a and 2830b of the river from Quebec to Lachine, to a scale of 10:335 feet nearly per inch, which are submitted herewith. (See illustrations Nos. XXVI. and XXVII.)§

These sections of the main line inclusive of check lines, &c., may be described as follows; the order in which the levelling operations had to be carried out and the bench marks made numbered, for reasons of economy and others, being adhered to with the object of preventing confusion.

#### SECTION No. 4.

The levelling operations were commenced in the City of Sorel, at B<sup>C</sup><sub>78</sub>M on a boundary stone of South-Eastern Railway property, west side of King Street, nearly opposite Jacques Cartier Street, and carried on in an easterly direction through Victoria Street, and along the post and concession roads, &c., as shown approximately on Illustration No. XXVI., until the Village of St. Antoine de la Baie du Febvre was reached.

Total length of Section No. 4. ....

Description and elevations of bench marks, &c., given in abstract of results No. IV. A embodied herein, pages 10 to 17. Corresponding computation sheets, 78 in number, contained in Appendix No. \*1. Levelling operations recorded in geodesic level books Nos. 36, 37, 38, 39, 40, 41, 42, handed in herewith.

In connection with this section of the main continuous double line, levels were run, as shown in level books Nos. 96, 105 and 113, on the 23 computation sheets contained in Appendix No. 1\* and in abstract of results No. IV. B, Appendix No. 12\*, viz. :-

Carried forward.....

Statute  
Miles

30.400

30.400

\*Not published.

§ Chart No. 2830a, with additions (Ill. XXVI.), reproduced by lithography in two parts, numbered XXVIa and XXVIb, to a scale of 10,000 ft. per inch.

Chart No. 2830b, with additions (Ill. XXVII.), also lithographed in two parts, numbered XXVIIa and XXVIIb, to a scale of 10,000 ft. per inch.

	Statute Miles.
Brought forward. ....	30.4058
(a). On the south shore of the St. Lawrence :—	
C	
1st. Twice from B→M on D. Cardin's brick house, west side River Yamaska, near XLI cross road leading to Abenakis Springs, down to the Yamaska lock, viz. : the first time, 26th September, 1884, and again 3rd July, 1888, with a view of verifying the reported considerable settlements of the last named structure. Total subsidence of side walls together with sill at upper end of lock chamber, found to have been only 0.0336 ft. since 1884. 0.93 miles × 2 = .....	1.8600
2nd. From gauges put up on east and west shores, River Yamaska, near lock, to flood marks, &c. Total mileage. ....	0.1819
C	
3rd. From B→M on D. Courchesne's brick house, opposite the Abenakis Springs XLIV hotel, along the road on the west side of River St. Francis, in a north- westerly direction towards Lake St. Peter, to flood marks made by Mayor Crevier, of the parish of St. François du Lac and other parties. ....	2.3414
C	
4th. From B→M on Jos. Laramée's brick house, Pierreville Mills, to B→M on a XLV cut stone monument planted at mouth of main channel, River St. Francis. ....	2.4057
C	
5th. From B→M on Nestor Duguay's stone house, Village of Baie du Febvre, at LI intersection of road leading to the parish church with the post road, north- ward to Lake St. Peter. ....	2.1022
(b). On the north shore of the St. Lawrence :	
1st. From St. Lawrence to flood marks pointed out by Louis Gervais in his house, west side of road along River, Rang Nord, parish of St. Barthélémy. ....	0.0329
2nd. From high water marks pointed out by Honoré Vadeboncoeur around his dwelling house, shed and stables, south-west side River du Loup ( <i>en haut</i> ), near its mouth, to Lake St. Peter. ....	0.9544

## SECTION NO. 5.

This section extends from B<sub>146</sub>→M on stump on beach, in the division line between the par-  
ishes of Ste. Croix and Ste. Antoine de Tilly down to B→M made on the west wall of the  
Government Graving Dock at St. Joseph de Lévis.  
LXXIV

Levelling carried on in a north-easterly direction for a distance of ..... 30.7233  
Results given in Abstract V., page 18 of this report. For corresponding computation  
sheets, see Appendix No. 2\*, 78 pages.

Levels on main line, loop lines and cross sections, recorded in geodesic level books Nos.  
47, 48, 49, 50, 54, 55, 56, 57, 58, 63, 64, 96, 98, 102, 114 and 115.

A loop line was levelled from B→M made on the solid rock at the foot of Basile's Hill,  
parish of St. Nicholas, *via* north shore of St. Lawrence to B→M at foot of retaining wall,  
Davidson's Hill, in George Couture's yard, Lévis, together with an extension to the Louise  
locks at Pointe à Carcy, and a spur line from B→M on the Church of Notre Dame de la  
Garde, Champlain Street, Quebec, to the Quebec Observatory, on the Cove Fields, and Mar-  
telle Tower No. 2, near Grande Allée, 344 feet above the mean sea level. Total distance passed  
over ..... 10.7641

[N.B. — This loop line comprises two crossings of the St. Lawrence estuary, which were  
effected by making each time two sets of simultaneous observations with instruments placed  
at nearly equal altitudes on opposite shores. One of these crossings was made at the con-  
tracted part of the river opposite Basile's Hill, and the other from the Queen's Wharf, Que-  
bec, the whole as explained at length in the progress report submitted to you under date of  
December 9, 1886, a copy of which is annexed hereto. See Appendix No. 13.]

Results of loop line levelling contained in Abstract No. V., pages 24 to 26 of this report ;  
corresponding computation sheets, 51 in number, to be found in Appendix No. 3\*.

Carried forward. .... 81.7717

\* Not published.

	Statute Miles.
Brought forward.....	81.7717
On the south shore of the St. Lawrence levels were run from the main line to tide-water gauges, etc., at 22 points; the total distance gone over being.....	5.1097
On the north shore levelling was done for similar purposes at six points; the sum of the distance covered forming.....	2.4072
For water levels, elevations of gauges, &c., see abstract of results No. V-A, in Appendix No. 12*; computation sheets, 28, contained in Appendix No. 2.*	

## SECTION No. 6.

Commenced at B<sup>C</sup>⊖M in division line between the parishes of St. Antoine de Tilly and 146  
Ste. Croix, was levelled along the beach in a westerly direction, up to B<sup>C</sup>⊖M made on stone foundation of Louis Lafond's house at mouth of Petite Rivière du Chêne. LXXXIX

Total length of section.....	25.4581
Additional levelling performed in connection with eight special bench marks.....	2.1861
Results given hereunder in Abstract No. VI.; computations shown in Appendix No. 4*, 64 pages.	
On south shore of St. Lawrence, water levels established at 24 places; also elevations of several gauges put up around Pointe Platon wharf and at Lotbinière; moreover, Grondines gauge connected with main line by water level. Total distance gone over with spirit level....	8.6802
On north shore, flood levels established at Portneuf, Deschambault and Grondines; also elevations of Grondines and Deschambault gauges, involving levelling over a total length of....	6.6671
For results: see Abstract VI-A, Appendix No. 12*; corresponding computation sheets, No. 68, contained in Appendix No. 4.*	
Levels taken in connection with this section recorded in books Nos. 51, 52, 53, 59, 60, 61, 62, 63, 99, 102, 103, 104, 114 and 115.	

## SECTION No. 7.

Levelled from B<sup>C</sup>⊖M on stone basement of David Provencher's residence, near division line between parishes of Bécancour and Gentilly, westwardly along the post road to B<sup>C</sup>⊖M on Nestor Duguay's stone house, Village of Baie du Febvre. Total length of section..... LI

Additional levelling required for determining elevations of four special bench marks....	29.5451
Results will be found in Abstract No. VII. embodied in this report; computation sheets in Appendix No. 5*. Water levels taken on south shore at nine points; also elevations of Doucet's Landing and Port St. Francis gauges established, necessitating the running of levels over a distance of.....	4.3373
On north shore, elevations of flood marks established at Cap de la Magdeleine, Three Rivers and Pointe du Lac; also height of gauge used by Three Rivers Harbour Commissioners, which involved the running of levels over a total distance of.....	2.8832
Water levels, etc., given in Abstract No. VII., Appendix No. 12*; computation sheets in Appendix No. 5.*	0.8037
Field operations performed in connection with Section No. 7, recorded in geodesic level books 64, 65, 66, 67, 68, 69, 70, 71, 100, 101, 104, 105, 113 and 114.	

## SECTION No. 8.

Run from B<sup>C</sup>⊖M near division line between parishes of Bécancour and Gentilly, at eastern end of Section No. 7 just described, in an easterly direction to B<sup>C</sup>⊖M at upper end of Section No. 6, mouth of Little River du Chêne, parish of St. Jean des Chaillons. LXXXIX

Total length of section.....	24.6028
First 8 miles levelled along the post road, viz., as far as the lower end of Gentilly village; beach followed for the remainder of the distance. Extra levelling entailed by the establishment of four special bench marks.....	2.7729
See abstract of results No. VIII. which here follows. Details of computations shown in Appendix No. 6.*	

Carried forward.....	197.2251
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Statute  
Miles.  
197 2351

## Brought forward

Flood and other river levels established at ten places on the south shore of the St. Lawrence and Batiscan and Champlain gauges connected with main line by water level, which associated the running of levels over

5 9073

on the south of the St. Lawrence, check line levelled from Champlain Church to Richelieu (where Navigation Company's wharf at Batiscan); also elevations of flood marks determined at Champlain village and on Rivers Champlain and Batiscan, involving altogether 24 gaugings over a distance of

8 6535

At difference of height between B.M. on parish church of St. Pierre les Becquets, CNIII and B.M. on stump at Gentilly opposite

305

at gauging at Longueville wharf, deduced from main line levelling on south shore, found 16 feet, with difference of elevation between same points deduced from water level and connecting line of check levels run on north shore. Abstract of results on water level shore and cross sections, etc., run from this line to the river, etc., will be given in Appendix No. 12, pages 39 to 42, as also the corresponding computation sheets, 40 to 42, and Appendix No. 6.

Level was continued in connection with Section No. 8, recorded in geodetic level books Nos. 74, 75, 76, 77, 78, 79, 100, 101, 104 and 115.

## SECTION No. 9.

Survey at B.M. on the Sorel market hall and levelled along the post road, the whole

CNXVI

B.M. on large elm tree on Fabien Lacombe's farm, parish of Varennes, about 2 miles

from parish church

Total length of section

31 3910

On May 25th, 1888, bench well G, put down in 1884, close to the old wind mill on River Richelieu, in the city of Sorel, was transferred to St. Joseph de Sorel on the north of the said river, for the following reasons: 1st. I was informed by Mr.

McCarthy that B.M. cut on the brickwork of Messrs. McCarthy's residence, the only

CNXVII

stone foundation under that part of their house. 2nd. Bench well G, as first intended to be a very convenient post for snubbing purposes, in consequence of which was soon removed and the well partly filled with rubbish.

The work done in connection with this transfer

0 1122

Levelled cross sections, Section No. 9, given in Appendix No. 7, containing 120 sheets, from Sorel to the village of Varennes, No. IX, follows hereunder. See pages 48 to 55. On the water level run to River St. Lawrence; also elevations established of several gauges and other gauges put up at St. Joseph de Sorel, Contrecoeur and Varennes, at which monument spirit levelling over a distance of

7 3613

at which the heights reached by floods determined at four places, viz., at Bethune, La Motte and Repentigny; total distance gone over

0 4234

Abstract of results, No. IX, A in Appendix No. 12, pages 43 to 46, and corresponding computation sheets in Appendix No. 7.

Level work recorded in level books Nos. 82, 83, 84, 85, 86, 87, 96, 97, 106, 113, 114 and 116.

## SECTION No. 10.

Survey at new mark on coping east side of abutment at southern end of new Canadian

on the railway bridge across the St. Lawrence, between Caughnawaga and Lachine, was

on the post road north easterly all the way down to B.M. already described,

at the village of Varennes, with the exception of the last 17 miles which were on the fields between the road and the river, to cut off a long detour of the

on the high ground

Total length of section.

33 9444

## Carried forward

261 9723

Not published

At the order to prevent boys from unscrewing the bolts which keep it up the covers, breaking up and throwing stones, earth or other rubbish into the water, these were exposed to the fair play of the boys and have in 1888 been protected by cast iron cylinders about 1.5 feet in diameter and 1.5 feet high, having flanges at bottom and closed at top by conical caps and the same were placed at 100 to 200 ft. each, which are supported on pieces of cedar placed about 1 foot apart.

Brought forward.

Additional levelling between B<sup>C</sup> M and special bench mark B<sup>C</sup> M made from 10 to 11  
251 CXXXV  
feet above low water on upper side of southern abutment of bridge, near the north-west angle  
of the former.

0.8580

N.B.—This bench mark is now buried in the earth protection slope formed around the  
base of the abutment.

Check line run from B<sup>C</sup> M on large elm stump on northern bank of Little Montreal  
63  
River, 30 to 40 feet above the bridge at the intersection of the turnpike road between Chambly  
Basin and Longueuil, with the post road along the west side of River Richelieu, to B<sup>C</sup> M on  
CXIII  
the Roman Catholic parish church of Longueuil, viz., with a view of closing the circuit of  
levels, 103.6186 miles long, which were run from this town along the River St. Lawrence to  
Sorel and thence to Chambly Basin, rid the valley of the River Richelieu.

0.26 feet of elevation was lost in making this circuit of 103.6186 miles.

Mean error for whole distance = 0.07875 feet.

Probable error do = 0.05312 "

Total length of check line.

12.0754

Loop line headed Section No. 10<sup>4</sup>, levelled rid north shore of St. Lawrence from B<sup>C</sup> M  
283  
balm of Gilead tree on south shore opposite lower end of St. Helen's Island, across the River  
St. Lawrence and the said island to B<sup>C</sup> M on east face southern abutment Canadian Pacific  
M

Railway subway at Brock Street, Montreal, and thence westward to bench mark <sup>^</sup> on coping  
of southern or Caughnawaga abutment, new Canadian Pacific Railway bridge, and eastward  
to new sugar refinery, Hochelaga, together with an extension at the upper end from B<sup>C</sup> M  
in second course of stone above ground, west face of first pier at north or Lachine end new  
Canadian Pacific Railway bridge, to the upper end of the Lachine Canal entrance channel at  
Lachine.

Total mileage of levelling done on these check and loop lines.

20.9507

N.B.—The 1.1211 miles run from B<sup>C</sup> M on coping west side of abutment, Caughnawaga  
end of new Canadian Pacific Railway bridge, over this bridge and along the post road up to  
B<sup>C</sup> M on the Roman Catholic parish church of the town of Lachine form part of the section,  
say No. 11, proposed to be levelled thence westward.

The loop line just described was run with a view of connecting the Lachine Canal with the  
main line of levels; establishing permanent geodesic bench marks along the Montreal Harbour  
front, and determining the slope of the St. Lawrence between the said city and the town of  
Lachine along the north shore, as well as the elevations of flood marks made on this shore,  
below the Lachine rapids; beyond the western city limits the post road was followed the  
greater part of the way to Lachine. Results arrived at on main line section No. 10 given in  
Abstract No. X., and those of the other lines just described are contained in Abstract No. X-A,  
both of which are embodied herein. For details of computations, see Appendices Nos. 8\*, 9\*,  
10\* and 11\*.

In addition to the above, the following operations were carried out in connection with  
section No. 10, viz.:

1. Establishing the heights of several high and low water gauges which were read in  
different seasons of the year at Laprairie, Longueuil and Varennes, and also flood, ordinary  
and low water levels at 106 points on the south shore up to the new Canadian Pacific Railway  
bridge, which entailed the running of levels over a distance on the north shore of

8.2373

2. Determining ordinary river and flood levels at 128 points; also the elevations of mitre  
sills, etc., of locks Nos. 1 and 5, Lachine Canal, etc.; the total distance passed over with the  
spirit level being

3.7760

For results, see Abstract No. X-B, Appendix No. 12\*, pages 70 to 122. Computation  
sheets included in Appendices Nos. 8\*, 9\*, 10\* and 11\*.

For record of field operations, see level books Nos. 79, 80, 81, 88, 89, 90, 91, 92, 93, 94, 95,  
96, 97, 106, 107, 108, 109, 110, 111, 112, 113, 115 and 117.

Add for:

1. Connection, in 1888, of bench well A near the International Boundary at Rouse's Point,  
with BM<sup>C</sup>, U.S.C. and G.S. on water sill under window north side of Chapman's block of  
stores, Village of Rouse's Point, and verification of levels taken in 1883-84 to base course of  
scarp wall, bastion B, Fort Montgomery, etc.

2.1525

Carried forward

333.0422

Miles.

Brought forward.....

333 0427

Abstract of results given on page 123, Appendix No. 12; computation sheets contained in book No. 11\*, pages 29 to 32.

Foot work recorded in level book No. 107.

2 Verification, in August, 1880, of crossing effected in October, 1867, by water from Les Grondines or Rte. Emmet, south shore, to Grondines wharf, on the north shore of the St. Lawrence.

0 6028

The result of this work was to disclose the fact, that the large white birch tree on the hill opposite Grondines wharf, on which B.M. had been made July 7, 1866,

180

had subsided with the hill between July, 1866, and October, 1867, to a level 0.53 feet below that which it occupied originally; and furthermore, that between October, 1867, and August, 1880, the hill had subsided to an additional depth of nearly 1.44 feet (see book No. 12\*, page 25 for abstract of results). Computation sheets in Appendix No. 47, pages 41, 42, and 120f. Field work recorded in level book No. 118.

Total mileage of levelling performed in connection with sections Nos. 4 to 10, etc.

333 6470

Notes on level.

It will be seen by referring to the mean and probable errors which have been computed for all the sections separately, that the levelling operations continue to be kept up to the standard of accuracy usually called for in Europe and the United States of America. As fully explained in my report dated 26th June, 1884, the observer may, according to the rules adopted in these countries, accept for short distances / between two bench

marks a discrepancy of  $3'' = \sqrt{\frac{1.44}{1000}} \times 2 /$  corresponding to nearly 0.03 foot per mile;

for sections of 25 to 50 or 100 miles or more the mean error developed per mile

should not exceed  $3'' = \sqrt{\frac{1.44}{1000}} = 0.0126$  feet, or that developed in the whole distance  $L$ ,

should not exceed  $0.0126 \sqrt{L}$ .

Taking up the seven sections of the continuous line of levels run between Quebec and Saguenay as a whole, the following mean and probable errors indicating the general accuracy of the field work performed on the 205.9305 miles covered by these sections are arrived at

M. Mean error for whole distance ..... 0.00728 feet.

P. Probable error for whole distance 0.6745 M ..... 0.06562 "

M. Mean error per mile ..... 0.00678 "

P. Probable error per mile 0.6745 M ..... 0.00457 "

#### DATUM.

The plane of reference adopted for all elevations established between Quebec and Saguenay is the mean level of the Atlantic at the mouth of the Gulf of St. Lawrence, the vertical position of which was approximately determined by me at Quebec in 1880-82, from the data afforded by the Admiralty charts of the St. Lawrence and series of cross-river gaugings made under the supervision of this department and the Montreal Harbour Commissioners.

The method I adopted in fixing at the city of Quebec, in an approximate manner, the mean sea level of the Atlantic in the Gulf of St. Lawrence, pending the accurate determination of the same by means of extended tidal and barometric and other meteorological observations made at some point along the Gulf shore, such as Cape Rosier, Saguenay, and the completed circuit of levels above alluded to is fully described in the Appendix hereto (See Appendix No. 21.)

It will be seen by a perusal of this note, that two computations of the approximate elevation of the mean sea level in reference to the 0 of a gauge that was put up by my direction in 1881-82 at the foot of St. James street, St. Peter's ward, Quebec, were made. One, or say No. 1, was based on data taken from a cross-section of the River St. Lawrence, designated by the letter A, which was taken at a point  $1\frac{1}{4}$  mile west of the village of Lanoraie, where the river bed is contracted to a width not exceeding  $1\frac{1}{4}$  mile, and the other, or No. 2, on data taken from a section, C, made across the Lake St. Peter flats where the stream is nearly  $7\frac{1}{2}$  miles wide. The two results thus arrived at differ by about 2.0 feet, mean sea level No. 1, viz., that based on cross-section A being found to be about 2.0 feet lower than No. 2, or that based on cross-section C.

When levelling operations were commenced at Quebec in 1885-86, the lowest height arrived at was adopted as a datum; but having examined more closely into the matter after the first season's work was completed, I came to the conclusion, for the reasons stated at the end of note A, that the higher of the two levels determined, viz., that based on cross-section C would probably turn out to be the most correct. I consequently raised the datum first used, 2.0 feet, so as to make its height correspond with the results of computation No. 2. This will explain why the elevations of bench marks, &c., given in the report submitted to you under date of 26th December, 1886, on the determination of the relative coping heights of the walls of the graving dock at Lévis, and those of the Louise Basin at Quebec are two feet less than the corresponding elevations which appear in the abstracts of results now transmitted.

In July, 1888, 11th to 13th, bench well A planted on the international boundary line, near the village of Rouse's Point, was connected with bench mark  $\oplus$ , made in 1882 by Mr. Assistant Tittmann, of the U.S. C. and G. Survey on stone water sill under second window, 21.5 feet from N. E. corner north front of Chapman's brick block, which stands at the S. W. corner of Lake and Champlain streets in the said village.

The Coast and Geodetic Survey authorities place the elevation of this B. M. at 110.06 feet above the mean sea level at Governor's Island, New York harbour, in the report by Mr. Assistant Schott dated 10th October, 1887, already referred to, with an extract of which the department was favoured 11th May, 1888. (See Appendix No. 14.)

In this report it is stated: 1st, that the mean sea level adopted is that deduced from tidal observation in New York harbour, made by Coast Survey at Governor's Island between 1852 and 1879 inclusive (comprising, therefore, one and a half revolutions of the moon's nodes), which was transferred by water level to east bank Hudson River, foot of 18th street; 2nd, that the elevation of the bench mark on the Chapman block depends on spirit levelling along the eastern side of the Hudson River by J. B. Vose in 1857-58, and on operations performed by O. H. Tittmann up to 1887 with the spirit level, along the Erie and Champlain Canals and the track of the Delaware and Hudson Canal Company's Railroad, as far as Putnam station at the southern end of Lake Champlain, and thence by water level to Rouse's Point, where he connected the lake level with the bench mark on the Chapman block.

Mr. Schott places the probable error or uncertainty of the average elevation of Lake Champlain (97.17 feet) which has been deduced by him from the readings of the water level made by the United States engineers at Fort Montgomery between 1871 and 1882, when taken in connection with the levelling operations just described: at about 0.3 feet (exclusive of uncertainty due to secular change), and the elevation of the bench mark on the Chapman block, viz., 110.06 feet, must be at least as nearly correct as the average lake level referred to. On the other hand, I make out the elevation of Mr. Tittmann's bench mark at Rouse's Point to be 114.5010 feet above the mean level of the Atlantic in the Gulf of St. Lawrence, as approximately determined by me at Quebec in 1882, which result shows that my datum is  $(114.5010 - 110.0600) = 4.4410$  feet below the plane of reference adopted by the U.S. C. and G. Survey, viz., the mean level of the Atlantic at Governor's Island, as transferred to Rouse's Point.

The law according to which the estuary would be drawn down Quebec harbour at low water, by tides of smaller amplitude than that corresponding to the minimum astronomical coefficient 30. until all trace of tidal influence would disappear, cannot, of course, be

represented graphically by a curve or a right line drawn with the aid of co-ordinates resulting from experimental results, the same as has been done for several of the complete series of gaining and losing tides with coefficients varying between 39 and 117 observed at this place. We may assume, however, without risk of going far astray, that in the said series the average rate of depression of the low water level is sensibly uniform for all the undulations whether the amplitudes correspond to theoretical coefficients between 30 and 117 or between 30 and 0.

In so doing we can err only on the right side, as regards the object now in view, the general geometrical loci of the low water levels of both the gaining and losing tides observed in the fall of 1887, while the fresh water discharge remained nearly constant, are sensibly straight lines but slightly inclined to the horizon, and the width of the estuary at low tide increases as the tidal undulations decrease in importance. Now I find, proceeding on the basis just defined, that according to the results of the operations performed between New York harbour and Rouses Point which are given by Mr. Schott, in his report of October, 1887, above referred to, the Governor's Island mean sea level is more than three feet above the level at which the St. Lawrence would flow in Quebec harbour if the estuary was tideless and the river at the stage when the discharge is equal to some 300,000 cubic feet per second and the depth on the lower bank No. 1, foot of Lachine Canal, about 16 feet.

As it is manifestly impossible for the mean level of the Atlantic in the Gulf of St. Lawrence to be at a greater absolute height than the level of the river abstracted from the whole of the tides would be at Quebec, some 800 miles inland, the greater portion, or the whole of the difference of 4.44 feet between the elevation of the approximate mean sea level datum adopted by me and the Governor's Island mean sea level, and which is more than 4.44 feet, will have to be accounted for in some other way. Under these circumstances, I concluded, after mature consideration, to retain my own datum for the completion of the proposed line of levels from Quebec down to a place on the St. Lawrence suitable for the establishment of a properly equipped gauging station, as suggested by me in the progress report submitted to you on the 9th December, 1886 (Appendix No. 15), and the determination of the mean level of the Atlantic at this place by means of continuous series of accurate gaugings made during several years.

	Statute Miles.
Brought forward.....	81 777
On the south shore of the St. Lawrence levels were run from the main line to tide-water gauges, etc., at 22 points; the total distance gone over being.....	5 188
On the north shore levelling was done for similar purposes at six points; the sum of the distance covered forming.....	2 462
For water levels, elevations of gauges, &c., see abstract of results No. V-A, in Appendix No. 12 <sup>o</sup> ; computation sheets, 28, contained in Appendix No. 2 <sup>o</sup> .	

## SECTION NO. 6.

Commenced at B.C.M. in division line between the parishes of St. Antoine de Tilly and St. Croix.

was levelled along the bench in a westerly direction, up to B.C.M. made on stone foundation of Louis Lafond's house at mouth of Petite Rivière du Chêne.

Total length of section.....	25 451
Additional levelling performed in connection with eight special bench marks.....	2 181
Results given hereunder in Abstract No. VI; computations shown in Appendix No. 4 <sup>o</sup> .	

On south shore of St. Lawrence, water levels established at 24 places; also elevations of several gauges put up around Pointe Platon wharf and at Locunere; moreover, Groundlines gauge connected with main line by water level. Total distance gone over with spirit level.....

On north shore, flood levels established at Portneuf, Deschambault and Groundlines; also elevations of Groundlines and Deschambault gauges, involving levelling over a total length of.....

For results, see Abstract VI-A, Appendix No. 12<sup>o</sup>; corresponding computation sheets, No. 68, contained in Appendix No. 4<sup>o</sup>.

Levels taken in connection with this section recorded in books Nos. 71, 72, 73, 79, 80, 81, 82, 83, 89, 102, 103, 104, 114 and 115.

## SECTION NO. 7.

Levelled from B.C.M. in stone basement of David Provencier's residence, near division line between parishes of Beauceville and Gentilly, westwardly along the post road to B.C.M.

in Notre-Dame's stone house, Village of Baie du Royon. Total length of section.....	29 343
Artificial levelling required for determining elevations of four special bench marks.....	4 353

Results of section in Abstract No. VII, as stated in this report; computation sheets in Appendix No. 5<sup>o</sup>. Water levels taken at tide gauges, also elevations of Provencier's Landing and Notre-St. Francois gauges established, representing the running of levels over a distance.....

On north shore, elevations of flood marks established at Cap de la Magdeleine, Three Rivers and Baie du Royon; also height of gauge used in Three Rivers Harbour Commission, which is used for running of levels over a distance of.....

Water levels, elevations in Abstract No. VII, Appendix No. 12<sup>o</sup>; computation sheets in Appendix No. 5<sup>o</sup>.

Levels taken in connection with section No. 7, recorded in geodetic level books 84, 85, 86, 87, 88, 89, 90, 91, 106, 107, 108, 109, 110 and 114.

## SECTION NO. 8.

Run from B.C.M. near the mouth of the Rivière du Chêne in Beauceville and Gentilly, at eastern end of Section No. 7, westwardly, in an easterly direction to B.C.M. at junction of Section No. 8 with Rivière du Chêne, near St. Jean des Hauts.

Total length of section.....	24 685
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Water levels taken at tide gauges, also height of gauge used in Three Rivers Harbour Commission, which is used for running of levels over a distance of.....

See Abstract VIII, Appendix No. 12<sup>o</sup>; computations shown in Appendix No. 5<sup>o</sup>.

Carried forward.....

125 251

	Statute Miles.
Brought forward.....	197.2251
Flood and other river levels established at ten places on the south shore of the St. Lawrence, and Batiscan and Champlain gauges connected with main line by water level, which necessitated the running of levels over.....	5.9973
On the north of the St. Lawrence, check line levelled from Champlain Church to Richelieu and Ontario Navigation Company's wharf at Batiscan; also elevations of flood marks determined at Champlain village and on Rivers Champlain and Batiscan, involving altogether levelling operations over a distance of.....	8.6535
N.B. Difference of height between B <sup>C</sup> on parish church of St. Pierre les Becquets, opposite Batiscan gauge at Brunelle's wharf, and B <sup>C</sup> on stump at Gentilly opposite Champlain gauge at Gagnon's wharf, deduced from main line levelling on south shore, found to agree within 0.16 feet, with difference of elevation between same points deduced from water level crossings and connecting line of check levels run on north shore. Abstract of results on check line north shore and cross sections, etc., run from this line to the river, etc., will be found in Appendix No. 12,* pages 39 to 42, as also the corresponding computation sheets, 40 in number, in Appendix No. 6.*	
Field work performed in connection with Section No. 8, recorded in geodesic level books Nos. 72, 73, 74, 75, 76, 78, 99, 100, 101, 104 and 115.	
SECTION NO. 9.	
Started at B <sup>C</sup> on the Sorel market hall and levelled along the post road, the whole way up to B <sup>C</sup> on large elm tree on Fabien Lozeau's farm, parish of Varennes, about 2 miles below the parish church.	
Total length of section.....	31.2609
On Saturday, August 25th, 1888, bench well G put down in 1884, close to the old wind-mill, east side River Richelieu, in the city of Sorel, was transferred to St. Joseph de Sorel on the west side of the said river, for the following reasons: 1st. I was informed by Mr. John McCarthy that B <sup>C</sup> on the brickwork of Messrs. McCarthy's residence—the only permanent bench in that locality—would probably soon have to be removed as they intended to rebuild the stone foundation under that part of their house. 2nd. Bench well G, as first put down, proved to be a very convenient post for snubbing purposes, in consequence of which the cover had been removed and the well partly filled with rubbish.†	
Extra levelling done in connection with this transfer.....	0.1122
Details of computations, Section No. 9, given in Appendix No. 7*, containing 126 sheets. Abstract of results, Section No. 9, viz., No. IX. follows hereunder. See pages 48 to 55. On south shore 44 spur lines run to River St. Lawrence; also elevations established of several high and low water and other gauges put up at St. Joseph de Sorel, Contrecoeur and Verbois, all of which necessitated spirit levelling over a distance of.....	7.3855
On north shore the heights reached by floods determined at four places, viz., at Berthier, Lacornie, Lavaltrie and Repentigny; total distance gone over.....	0.4234
See abstract of results, No. IX—A in Appendix No. 12*, pages 43 to 69, and corresponding computation sheets in Appendix No. 7*.	
Field work recorded in level books Nos. 82, 83, 84, 85, 86, 87, 96, 97, 106, 113, 114 and 116.	

## SECTION NO. 10.

<p>Began at bench mark <math>\nabla</math> on coping east side of abutment at southern end of new Canadian Pacific Railway bridge across the St. Lawrence, between Caughnawaga and Lachine was levelled following the post road north-easterly all the way down to B<sup>C</sup> M, already described, about 2 miles below the village of Varennes, with the exception of the last 1½ miles which were run through the fields between the road and the river, to cut off a long detour of the road along the brow of the high ground.</p> <p>Total length of section.....</p> <p>Carried forward.....</p>	<p>33.9344</p> <p>284.9923</p>
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\*Not published.

†N.B.—In order to prevent boys from unscrewing the bolts which keep down the covers, breaking off the lugs and throwing stones, earth or other rubbish into the wells, those most exposed to be tampered with, viz., A, E and G have in 1888 been protected by cast-iron cylinders about 1.85 feet in diameter and 4 to 5 feet high, having flanges at bottom and closed at top by segmental caps all in one piece, and weighing from 400 to 500 lbs. each, which are supported on pieces of cedar placed about 1 foot under and.

Brought forward.		Station Miles.
		284.923
Additional levelling between B $\odot$ M and special bench mark B $\ominus$ M made from 10 to 11 feet above low water on upper side of southern abutment of bridge, near the north-west angle of the former	C 251 CXXXV	0.854
N.B.—This bench mark is now buried in the earth protection slope formed around the base of the abutment.		
Check line run from B $\odot$ M on large elm stump on northern bank of Little Montreal River, 30 to 40 feet above the bridge at the intersection of the turnpike road between Chambly Basin and Longueuil, with the post road along the west side of River Richelieu, to B $\odot$ M on the Roman Catholic parish church of Longueuil, viz., with a view of closing the circuit of levels, 103.6186 miles long, which were run from this town along the River St. Lawrence to Sorel and thence to Chambly Basin, and the valley of the River Richelieu.	C 63 CXIII	12.474
0.26 feet of elevation was lost in making this circuit of 103.6186 miles.		
Mean error for whole distance = 0.07875 feet.		
Probable error do = 0.05312 "		
Total length of check line.		
Loop line headed Section No. 104, levelled and north shore of St. Lawrence from B $\odot$ M balm of Gilead tree on south shore opposite lower end of St. Helen's Island, across the River St. Lawrence and the said island to B $\ominus$ M on east face southern abutment Canadian Pacific Railway subway at Brock Street, Montreal, and thence westward to bench mark — on coping of southern or Caughnawaga abutment, new Canadian Pacific Railway bridge, and eastward to new sugar refinery, Hochelaga, together with an extension at the upper end from B $\odot$ M in second course of stone above ground, west face of first pier at north or Lachine end new Canadian Pacific Railway bridge, to the upper end of the Lachine Canal entrance channel at Lachine.	C 283 M	20.457
Total mileage of levelling done on these check and loop lines.		
N.B. The 1.1211 miles run from B $\odot$ M on coping west side of abutment, Caughnawaga end of new Canadian Pacific Railway bridge, over this bridge and along the post road up to B $\odot$ M on the Roman Catholic parish church of the town of Lachine form part of the section, say No. 11, proposed to be levelled thence westward.		
The loop line just described was run with a view of connecting the Lachine Canal with the main line of levels; establishing permanent geodesic bench marks along the Montreal Harbour front, and determining the slope of the St. Lawrence between the said city and the town of Lachine along the north shore, as well as the elevations of flood marks made on this shore, below the Lachine rapids; beyond the western city limits the post road was followed the greater part of the way to Lachine. Results arrived at on main line section No. 10 given in Abstract No. X., and those of the other lines just described are contained in Abstract No. X-A, both of which are embodied herein. For details of computations, see Appendices Nos. 8*, 9*, 10* and 11*.		
In addition to the above, the following operations were carried out in connection with section No. 10, viz.:		
1. Establishing the heights of several high and low water gauges which were read in different seasons of the year at Laprairie, Longueuil and Varennes, and also flood, ordinary and low water levels at 100 points on the south shore up to the new Canadian Pacific Railway bridge, which entailed the running of levels over a distance on the north shore of		8.253
2. Determining ordinary river and flood levels at 128 points; also the elevations of miter sills, etc., of locks Nos. 1 and 2, Lachine Canal, etc.; the total distance passed over with the spirit level being		3.760
For results, see Abstract No. X-B, Appendix No. 12*, pages 70 to 122. Computations sheets included in Appendices Nos. 8*, 9*, 10* and 11*.		
For record of field operations, see level books Nos. 79, 80, 81, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 106, 107, 108, 109, 110, 111, 112, 113, 115 and 117.		
Add for		
1. Connection, in 1888, of bench well A near the International Boundary at Rouse's Point, with BM $\odot$ , U.S.C. and G.S. on water sill under window north side of Chapman's block of stores, Village of Rouse's Point, and verification of levels taken in 1883-84 to base course of scarp wall, bastion B, Fort Montgomery, etc.		2.123
Carried forward		335.042

	Miles.
Brought forward.....	333·0422
Abstract of results given on page 123, Appendix No. 12*; computation sheets contained in Appendix No. 11*, pages 29 to 39.	
Field work recorded in level book No. 107.	
2. Verification, in August, 1890, of crossing effected in October, 1887, by water level from Leclercville or Ste. Emmélie, south shore, to Grondines wharf, on the north shore of the St. Lawrence.....	0·6028
The result of this work was to disclose the fact, that the large white birch tree on the slope of the hill opposite Grondines wharf, on which B·M had been made July 7, 1886, had moved northward with the hill between July, 1886, and October, 1887, to a level 0·53 foot below that which it occupied originally; and furthermore, that between October, 1887, and August, 1890, the hill had subsided and additional depth of nearly 1·44 feet (see Appendix No. 12*, page 26 for abstract of results). Computation sheets in Appendix No. 4*, pages 54, 54½ and 120½ and 120¾. Field work recorded in level book No. 118.	
Total mileage of levelling performed in connection with sections Nos. 4 to 10, etc.	333·6450

\*Not published.

It will be seen by referring to the mean and probable errors which have been computed for all the sections separately, that the levelling operations continue to be kept up to the standard of accuracy usually called for in Europe and the United States of America. As already explained in my report dated 26th June, 1884, the observer may, according to the rules adopted in these countries, accept for short distances / between two bench marks, discrepancies  $d = 5^{m.m.} \sqrt{\frac{1 \text{ mile}}{1 \text{ kilom}}} \times 2 l$  corresponding to nearly 0·03 foot per mile; but for sections of 25 to 50 or 100 miles or more the mean error developed per mile should not exceed  $3^{m.m.} \sqrt{\frac{1 \text{ mile}}{1 \text{ kilom}}} = 0·0126$  feet, or that developed in the whole distance  $L$ , should not exceed  $0·0126 \sqrt{L}$ .

Taking up the seven sections of the continuous line of levels run between Quebec and Caughnawaga as a whole, the following mean and probable errors indicating the degree of accuracy of the field work performed on the 205·9305 miles covered by these sections, are arrived at:—

μ, Mean error for whole distance..... 0·09728 feet.

μ, Probable error for whole distance =  $0·6745 \mu$  .. = 0·06562 "

M, Mean error per mile..... = 0·00678 "

M, Probable error per mile =  $0·6745 M$  ..... = 0·00457 "

#### DATUM.

The plane of reference adopted for all elevations established between Quebec and Montreal is the mean level of the Atlantic at the mouth of the Gulf of St. Lawrence, the vertical position of which was approximately determined by me at Quebec in 1880-82, by means of data afforded by the Admiralty charts of the St. Lawrence and series of tide and river gaugings made under the supervision of this department and the Montreal Harbour Commissioners.

The method I adopted in fixing at the city of Quebec, in an approximate manner, the mean sea level of the Atlantic in the Gulf of St. Lawrence, pending the accurate determination of the same by means of extended tidal and barometric and other meteorological observations made at some point along the Gulf shore, such as Cape Rosier, Percé, &c., and the completed circuit of levels above alluded to, is fully described in note A appended hereto. (See Appendix No. 21.)

It will be seen by a perusal of this note, that two computations of the approximate elevation of the mean sea level in reference to the 0 of a gauge that was put up by my direction in 1881-82 at the foot of St. James street, St. Peter's ward, Quebec, were made. One, or say No. 1, was based on data taken from a cross-section of the River St. Lawrence, designated by the letter A, which was taken at a point  $1\frac{1}{4}$  mile west of the village of Lanoraie, where the river bed is contracted to a width not exceeding  $1\frac{1}{2}$  mile, and the other, or No. 2, on data taken from a section, C, made across the Lake St. Peter flats where the stream is nearly  $7\frac{1}{2}$  miles wide. The two results thus arrived at differ by about 2.0 feet, mean sea level No. 1, viz., that based on cross-section A being found to be about 2.0 feet lower than No. 2, or that based on cross-section C.

When levelling operations were commenced at Quebec in 1885-86, the lowest height arrived at was adopted as a datum; but having examined more closely into the matter after the first season's work was completed, I came to the conclusion, for the reasons stated at the end of note A, that the higher of the two levels determined, viz., that based on cross-section C would probably turn out to be the most correct. I consequently raised the datum first used, 2.0 feet, so as to make its height correspond with the results of computation No. 2. This will explain why the elevations of bench marks, &c., given in the report submitted to you under date of 26th December, 1886, on the determination of the relative coping heights of the walls of the graving dock at Levis, and those of the Louise Basin at Quebec are two feet less than the corresponding elevations which appear in the abstracts of results now transmitted.

In July, 1888, 11th to 13th, bench well A planted on the international boundary line, near the village of Rouse's Point, was connected with bench mark  $\Theta$ , made in 1882 by Mr. Assistant Pittmann, of the U. S. C. and G. Survey on stone water sill under second window, 21.5 feet from N. E. corner north front of Chapman's brick block, which stands at the S. W. corner of Lake and Champlain streets in the said village.

The Coast and Geodetic Survey authorities place the elevation of this B. M. at 110.96 feet above the mean sea level at Governor's Island, New York harbour, in the report by Mr. Assistant Schott dated 10th October, 1887, already referred to, with an extract of which the Department was favoured 11th May, 1888. (See Appendix No. 14.)

In this report it is stated: 1st, that the mean sea level adopted is that deduced from tidal observation in New York harbour, made by Coast Survey at Governor's Island between 1822 and 1879 inclusive, comprising, therefore, one and a half revolutions of the moon's nodes; which was transferred by water level to east bank Hudson River, foot of 15th street; 2nd, that the elevation of the bench mark on the Chapman block depends on spirit levelling along the eastern side of the Hudson River by J. B. Vose in 1857-58, and on operations performed by O. H. Pittmann up to 1887 with the spirit level, along the Erie and Champlain Canals and the track of the Delaware and Hudson Canal Company's Railroad, as far as Putnam station at the southern end of Lake Champlain, and thence by water level to Rouse's Point, where he connected the lake level with the bench mark on the Chapman block.

Mr. Schott places the probable error or uncertainty of the average elevation of Lake Champlain 47.17 feet, which has been deduced by him from the readings of the water level made by the United States engineers at Fort Montgomery between 1871 and 1882, when taken in connection with the levelling operations just described; at about 0.3 feet, exclusive of uncertainty due to secular changes, and the elevation of the bench mark on the Chapman block, viz. 110.96 feet, must be at least as nearly correct as the average lake level referred to. On the other hand, I make out the elevation of Mr. Pittmann's bench mark at Rouse's Point to be  $114.5010 - 110.9600 = 4.4410$  feet below the plane of reference adopted by the U. S. C. and G. Survey, viz., the mean level of the Atlantic at Governor's Island, as transferred to Rouse's Point.

The law according to which the estuary would be drawn down Quebec harbour at low water, is a matter of smaller magnitude than that corresponding to the minimum astronomical tide, and its influence would, therefore, cannot, of course, be

represented graphically by a curve or a right line drawn with the aid of co-ordinates denoting experimental results, the same as has been done for several of the complete series of gaining and losing tides with coefficients varying between 39 and 117 observed in 1887-88: we may assume, however, without risk of going far astray, that in the said harbour the average rate of depression of the low water level is sensibly uniform for all tidal oscillations whether the amplitudes correspond to theoretical coefficients between 30 and 118 or between 30 and 0.

In so doing we can err only on the right side, as regards the object now in view, for, the general geometrical loci of the low water levels of both the gaining and losing series of tides observed in the fall of 1887, while the fresh water discharge remained nearly constant, are sensibly straight lines but slightly inclined to the horizon, and the width of the estuary at low tide increases as the tidal undulations decrease in importance. Now I find, proceeding on the basis just defined, that according to the results of the operations performed between New York harbour and Rouse's Point which are given by Mr. Schott, in his report of October, 1887, above referred to, the Governor's Island mean sea level is more than three feet above the level at which the St. Lawrence would stand in Quebec harbour if the estuary was tideless and the river at the stage when its discharge is equal to some 300,000 cubic feet per second and the depth on the sill of old lock No. 1, foot of Lachine Canal, about 16 feet.

As it is manifestly impossible for the mean level of the Atlantic in the Gulf of St. Lawrence, to be at a greater absolute height than the level of the river abstracted from the influence of the tides would be at Quebec, some 800 miles inland, the greater portion, if not the whole of the difference of 4.44 feet between the elevation of the approximate mean sea level datum adopted by me and the Governor's Island mean sea level, and possibly more than 4.44 feet, will have to be accounted for in some other way. Under the circumstances, I concluded, after mature consideration, to retain my own datum pending the completion of the proposed line of levels from Quebec down to a place on the Gulf shore suitable for the establishment of a properly equipped gauging station, as suggested by me in the progress report submitted to you on the 9th December, 1886 (Appendix No. 15), and the determination of the mean level of the Atlantic at this station by means of continuous series of accurate gaugings made during several years.

IV A GEODETIC LEVELLING RIVER ST. LAWRENCE 1884-85.  
 ABSTRACT of Results, Section No. 4, Sorel to La Baie du Felyvre (Continuous line).

From	To	DIFFERENCE OF HEIGHT.			$\frac{2V^2}{M}$	B. M. W. S. ST. &c.	Distance from Levee Graving Dock rd line of levels.	Elevation, above - below level, Atlantic Ocean, approximate mean by R. Seeckel, 1880-82.	Locality, &c.
		M. Distance.	Line A. ←	Line B. →	Mean.				
		Miles.	Feet.	Feet.	Feet.		Miles.	Feet.	
B.M. 78	B.M. 116.	0 7046	3 6322	3 4535	3 6344	B. 78 C. M.	140 7350	53 1702	SOREL (City and Parish). B.M. 78—Top of boundary stone on property of S. E. R. R., west side King st., between J. Car- tier and Victoria. Stone mark- ed W D on back.
B.M. 116.	B.M. 117.	0 9601	+ 15 5004	+ 15 5183	+ 15 5124	B. 116 C. M.	130 9704	40 8308	B.M. 116—Brass-headed nail in root of red pine tree, east side of post road, on Senator J. Bie. Guévremont's property.
B.M. 117.	B.M. 118.	1 0504	+ 5 4650	+ 5 4725	+ 5 4692	B. 117 C. M.	138 0800	05 0522	B.M. 117—Brass-headed nail in root of pine stump in Ed. Baxter's field, 10 ft. west of road wire fence.
B.M. 118.	B.M. 119.	1 1504	25 1403	25 1613	25 1553	B. 118 C. M.	137 9200	70 5214	B.M. 118—Brass-headed nail in root of white pine tree in line of road fence, south-west side of post road.
B.M. 119.	B.M. 120.	0 2203	+ 17 0383	+ 17 0340	+ 17 0362	B. 119 C. M.	136 7042	45 3801	B.M. 119—Brass-headed nail in root of elm stump at foot of hill to Hotel de Sorel, 40 ft. north of road fence.
B.M. 120.	B.M. 121.	0 2203	+ 17 0383	+ 17 0340	+ 17 0362	B. 120 C. M.	136 5340	03 0013	B.M. 120—Copper plug in north-west gable of Benjamin Larochelle's brick house, at junction of post road and road to St. Victoire.

B.M. 119.	B.M. 120.	1 0845	+ 12 0450	+ 12 0420	+ 12 0440	+ 1 1	3 01	B. $\odot$ M. $\odot$ 120	38 3101	38 0797	130 0797	B.M. 120—Brass-headed nail in root of white pine tree, south side of road, 105 feet south of road fence, north con. No. 2, Pot au Beurre River.
<i>Parish of St. Anne de Sord.</i>												
B.M. 120	B.M. 121	1 0292	+ 9 4670	9 7046	9 7008	+ 3 8	28 05	B. $\odot$ M. $\odot$ 121	48 6043	134 6006	48 6006	B.M. 121—Brass-headed nail on top of stump of elm tree cut down for bench on north side of post road. South concession Second, Pot au Beurre River.
<i>Parish of St. Robert.</i>												
B.M. 121	B.M. 122	0 9211	+ 5 0002	5 0073	5 0038	+ 3 5	26 50	B. $\odot$ M. $\odot$ 122	43 6055	133 7284	43 6055	B.M. 122—Brass-headed nail in root of maple tree, 20 ft. south of road fence, between brook and road to St. Robert church.
<i>Parish of St. Michel de Yamaska.</i>												
B.M. 122	B.M. 123	1 0177	+ 0 0286	+ 0 0280	+ 0 0288	+ 1	02	B. $\odot$ M. $\odot$ 123	43 6343	132 7117	43 6343	B.M. 123—Brass-headed nail in root of balsam of Gilead tree in Joseph Desrosier's field, west side of road, on edge of gully.
<i>Parish of St. Joseph.</i>												
B.M. 123	B.M. xxxix	0 0620	+ 5 6137	+ 5 6161	+ 5 6149	+ 1 2	55 30	R. $\odot$ M. $\odot$ XXXIX	49 2492	132 6587	49 2492	B.M. XXXIX—Line on copper plug in stone monument planted (6 ft. in the ground) at junction of two roads, near Temperance Cross, opposite Jos. Desrosier's property, and Jean St. Germain's property.
B.M. 123	B.M. 124	0 9387	+ 5 3818	+ 5 3850	+ 5 3880	+ 7 0	104 40	B. $\odot$ M. $\odot$ 124	49 0232	131 7730	49 0232	B.M. 124—Brass-headed nail in root, south side of white pine tree in Jean St. Germain's field, 68 paces north of road fence, 812 ft. west of fence between St. Germain and Allard.
B.M. 124	B.M. 125	0 3296	+ 2 4806	+ 2 4838	+ 2 4831	+ 7 3	201 25	B. $\odot$ M. $\odot$ 125	51 0763	131 2434	51 0763	B.M. 125—Brass-headed nail in root of large elm tree in Joseph Fortier's fence line, 700 ft. from road; concession St. Louis.
Carried forward		9 4916	1 1970	1 2027	1 1960	+ 2 8	539 04					

\* All the figures in this column are written in red, to correspond with the tables, etc., for line A on the computation sheets, which are also shown in red, in order to reduce the chance of making errors to a minimum.

IV A - GEODETIC LEVELLING RIVER ST. LAWRENCE, 1884-85 - (Continued).  
 Abstract of Results, Section No. 4, Sorel to La Baie du Febvre (Continuous line). - Continued.

From	To	M. Distance.	DIFFERENCE OF HEIGHT.			V. Differ- ence from Mean.	$2\sqrt{2}$ M.	B. M. W. S. ST. &c.	Distance from Levis Graving Dock to line of levels	Elevation, above + below level, Atlantic Ocean, — approximate mean by R. Steckel, 1880-82.	Locality, &c.
			Line A. ←	Line B. →	Mean.						
		Miles.	Feet.	Feet.	Feet.	Feet. — 1000			Miles.	Feet.	
Brought forward.....		9.4916	1.1970	1.2027	1.1999	+ 28	539.04				<i>Parish of St. Michel de Yamaska</i> —Continued.
B.M. 125 .. B.M. 126.....		0.4719	+ 3.2491	+ 3.2281	+ 3.2381	+ 10.0	229.38	C. B. M. 126	130.3715	55.2144	B.M. 126—Brass-headed nail on top of pine stump at border of small bush, in rear of church; Hercule Mineau's land.
B.M. 126..... B.M. XLI.....		0.8257	+ 9.0326	+ 9.0331	+ 9.0329	- 0.2	0.97	C. B. M. XLI.	129.7454	04.2473	B.M. XLI—Copper plug in 1st quoin above plinth course, front Roman Catholic parish church, south-east corner, west River Yamaska.
B.M. 126., B.M. 127.....		1.9686	- 20.3415	- 20.3399	- 20.3407	- 0.8	0.98	C. B. M. 127	120.0679	34.8737	B.M. 127—Brass-headed nail in root of large elm tree on slope of hill, east side of river opposite church, on Edwars' La-vaux's land.
B.M. 127 .. B.M. 128.....		0.9056	4.7526	4.7244	- 4.7385	14.1	443.82	C. B. M. 128	128.1720	30.1352	B.M. 128—Brass-headed nail on ash stump, foot of steep hill, east bank of Yamaska River; Tonnancourt's land.
B.M. 128..... B.M. XLI.....		0.1745	+ 20.1936	+ 20.1916	+ 20.1926	+ 1.0	11.46	C. B. M. XLI	128.3465	50.3278	B.M. XLI—Copper plug in south gable of Daniel Cardin's brick house, a few hundred feet from lower road to St. Franois du Lac.

B.M. 129	B.M. 129	0 9456	3 8370	3 8424	3 8504	13 4	37 9 70	B. M. 129	129 117 8	33 0656	B.M. 129—Brass-headed nail on ash stump in Lachance de Ton- nancourt's field, west side of road to Yamaaka look.
B.M. 129	B.M. XLII	0 1502	- 9 2338	- 9 2291	- 9 2260	+ 2 1	35 40	B. M. XLII	129 2770	24 7598	B.M. XLII—Copper plug in second course below coping, west side upper end of Yamaaka lock.
B.M. 128	B.M. 130	0 8771	+ 19 5802	+ 19 5816	+ 19 5800	- 7	1 12	B. M. 130	127 2949	49 7161	B.M. 130—Brass-headed nail on top of white pine stump, 19 paces north of road fence on Autotte's land.
B.M. 130	B.M. 131	0 9268	+ 0 8840	+ 0 8842	+ 0 8841	- 1	0 22	B. M. 131	126 3681	50 6002	B.M. 131—Brass-headed nail on root, west side of pine tree, 4 ft. south of southern road fence.
B.M. 131	B.M. XLIII	1 0213	+ 3 7158	+ 3 7286	+ 3 7222	- 6 4	80 21	B. M. XLIII	125 3468	54 3224	<i>Parish of St. François du Lac.</i> B.M. XLIII—Copper plug about 7 feet from N.W. corner of Théophile Joyal's story and a-half brick house, S.E. side of post road.
B.M. XLIII B.M. 132	B.M. 132	1 2700	- 7 9455	- 7 9427	- 7 9441	- 1 4	3 09	B. M. 132	124 0768	463 783	B.M. 132—Brass-headed nail in root of soft maple tree, about 200 paces north of roadway on Moise Cartier's property.
B.M. 132	B.M. 133	0 9540	+ 0 8921	+ 0 8906	+ 0 8944	- 2 2	10 15	B. M. 133	123 1228	47 1827	B.M. 133—Brass-headed nail in root, S.E. side of soft maple tree, 3 ft. from fence, west side of road.
B.M. 133	B.M. XLIV	0 4874	+ 8 0314	+ 8 0638	+ 8 0676	- 6 2	157 74	B. M. XLIV	122 6354	55 2403	B.M. XLIV—Copper plug in rear wall, 2½ ft. from N.W. corner of Dominique Courchesne's brick house west side of post road to St. François du Lac church.
B.M. 133	B.M. 134	0 7769	- 18 2830	- 18 2876	- 18 2883	- 7	1 26	B. M. 134	122 3469	28 8044	B.M. 134—Brass-headed nail on root, north-west side of large ash tree, south of line fence between Dominique and Calixte Courchesne, opposite the Abenakis hotel.
Carried forward		18 3881	24 2654	24 2682	24 2618	- 13 6	1300 27				

IV A GEODETIC LEVELLING RIVER ST. LAWRENCE, 1884-85. *Continued.*  
 Abstract of Results, Section No. 4, Sored to La Baie du Felyre (Continuous line) *Continued.*

DIFFERENCE OF HEIGHT.											
From	To	Distance Miles.	Difference of Height.				V. Differ- ence from Mean.	$\frac{2V^2}{M}$ .	B. M. W. M. WT. &c.	Elevation, above + below level of Sea Level at Point of Observation (Approximate mean line of levels) Distance from level of Sea Level to Point of Observation	Locality, &c.
			Feet.	Feet.	Feet.	Feet.					
Brought forward											
B. M. 134	B. M. 135.	18 2881	24 2654	26 2682	24 2818	13 4	1840 27	C B. 135	121 5507	32 4370	Parish of St. Michel de Yamaska Continued. B. M. 135.—Brass-headed nail on rock, east side of basswood tree, on north east bank of Ile Ronde, about one mile, above Pierreville Mills wharf.
B. M. 135.	B. M. 136.	0 8730	3 2065	3 2072	3 2069	8	0 21	C B. 136	120 0404	30 1401	Parish of St. Thomas de Pierreville. B. M. 136 Brass-headed nail on rock, west side of balsm of Gill- weed tree, 20 ft. from waters edge, about 3 mile above cross- road; to mills, Jean Bernier's land.
B. M. 136.	B. M. X I. V.	0 0708	11 4078	11 4770	11 4872	10 2	310 43	C B. X I. V.	120 0156	40 0273	B. M. X I. V. Copper plug in south gable of Joseph Larame's storey and a-half brick house, east side of post road, a few hun- dred feet from cross-road to Pierreville Mills.
B. M. X I. V.	B. M. 137.	0 5185	12 3120	12 3005	12 3003	6 8	120 70	C B. 137	120 5340	28 3210	B. M. 137 Brass-headed nail on rock, west side of balsm of Gill- weed tree, close to Jean Bernier's farm, at a little bridge near the Richelieu Co.'s wharf.

*Parish of St. Michel de Yamaska*  
Continued.

B. M. 135—Brass-headed nail on  
rock, east side of basswood tree,  
on north east bank of Ile  
Ronde, about one mile, above  
Pierreville Mills wharf.

*Parish of St. Thomas de Pierreville.*

B. M. 136 Brass-headed nail on  
rock, west side of basin of Gill-  
weed tree, 20 ft. from waters  
edge, about 8 mile above cross-  
road; to mill, Jean Bernier's  
land.

B. M. X I. V. Copper plug in south  
gable of Joseph Laramé's story  
and a half brick house, east  
side of post road, a few hun-  
dred feet from cross-road to  
Pierreville Mills.

B. M. 137 Brass-headed nail on  
rock, west side of basin of Gillweed  
tree, close to Jean Bernier's  
fence at a little bridge near the  
Richardson (St. A. Vincent).

R.M. 137.	R.M. 138.	1 0827	1 3620	1 4179	1 4667	12 2	284 25	R. $\odot$ M. 138	121 5007	20 9123	B.M. 138—Brass-headed nail in root, west side of helm of Gilead tree, about 80 ft. from east shore of St. Francis River, say $\frac{1}{2}$ miles above its mouth.
R.M. 138.	R.M. XLVI.	0 8545	2 0672	2 1076	2 0874	10 2	243 51	R. $\odot$ M. XLVI	122 4212	24 8179	B.M. XLVI—Copper plug in head of stone monument planted near a bench mark on north-east bank of St. Francis River where it joins the St. Lawrence.
R.M. XLV	R.M. 139.	0 0803	13 1755	13 1611	13 1683	7 2	150 19	B. $\odot$ M. 139	119 3252	27 4500	B.M. 139—Brass-headed nail in root, east side of elm tree near water's edge in field south side of bridge across Chenal Tardif at Pierreville Mills.
R.M. 139.	R.M. XLVII.	0 1150	10 2642	10 2679	10 2661	1 8	56 35	R. $\odot$ M. XLVII	119 2102	37 7251	B.M. XLVII—Copper plug in north gable of Pierre Jod's brick-veneer house, east side of post road, along north bank of Chenal Tardif.
R.M. 139.	R.M. 140.	1 2428	4 6287	4 6325	4 6306	1 9	5 81	B. $\odot$ M. 140	118 0824	32 0606	B.M. 140—Brass-headed nail in root, south-west side of helm of Gilead tree in division line between Jos. Beaubien and François Laforce, north side of road.
R.M. 140.	R.M. 141.	1 3504	3 7068	3 7068	3 7068	0	0 00	B. $\odot$ M. 141	116 7320	35 7964	B.M. 141—Brass-headed nail in root of small ash tree in Victor Jutra's field, north side of post road, lot No. 106.
R.M. 141.	R.M. XLVIII.	0 2771	5 7128	5 7130	5 7129	1	0 72	B. $\odot$ M. XLVIII	116 4549	41 5083	B.M. XLVIII—Copper plug in western gable of Wm. Allard's story and a-half brick house on south side of post road, 5 75 ft. from north-west corner of house.
R.M. 141.	R.M. 142.	1 1347	6 0190	6 0101	6 0146	4 5	35 70	B. $\odot$ M. 142	115 5073	41 8110	B.M. 142—Brass-headed nail on north side of helm of Gilead tree on south side of road, on Calixte Fontaine's property.
Carried forward.		25 1377	11 3621	11 3683	11 3652	3 1	2107 85				

IV A CHORDOTIC LEVELLING RIVER ST. LAWRENCE, 1884-85 Continued.  
 Abstract of Results, Section No. 4, Sored to La Baie du Polyne (Continuous line) Continued.

m	To	DIFFERENCE OF HEIGHT.				V Inter ence from Mean.	2 V <sup>2</sup> M.	B. M. W. H. ST. &c.	Distance from Last Level to this one	Feet. 1000	Feet. 1000	Miles.	Feet. 1000	Locality, &c.
		From A.	From B.	Mean.										
Brought forward.														
B. M. 142.	B. M. 143.	11 3621	11 2983	11 3302		3.1	2107.06	G.	114 0020	41	4018			Parish of St. Thomas de Pierre-ville Continued. B. M. 143 Brass-headed nail on road, south side of large elm tree, north side of post road on Caliste Drole's property.
B. M. 143.	B. M. X L I X.	0 8663	7 7018	7 7048		1.0	2.30	G.	118 0127	40	1020			Parish of St. Antoine de la Baie du Polyne. B. M. X L I X Copper plug in east gable of Isaac Gouillard's solid brick house on south side of post road.
B. M. X L I X.	B. M. 144.	8 5214	8 5802	8 5208		7.4	83.02	G.	112 2055	40	4038			B. M. 144 Brass-headed nail in root of leaf of elm tree on north side of post road, in Philibert Oude's field.
B. M. 144.	B. M. 145.	6 0836	5 0242	5 0290		4.7	63.30	G.	111 4031	35	6340			B. M. 145 Brass-headed nail in road, north side of white oak tree close to southern road fence on Zael Chénier's land.
B. M. 145.	B. M. L.	1 1731	48 0000	48 0024		8.2	114.04	G.	110 2000	83	0073			B. M. L. Copper plug in tower of western tower of Beauport Catholic parish church on hill, west side of road.

B.M. 145	B.M. 141	1 1330	+ 12 8046	+ 12 8187	+ 12 8347	+ 10 0	480 80	B. 110 5262	48 4681	B.M. 141	Copper plug in south-east corner of basement under Neator Dugway's stone store, foot of hill leading to church.
Totals		30 4088	- 4 0734	- 4 7389	- 4 7046	+ 33 3	2803 55				

Section No. 4 = 30 4088 miles.

Mean error per mile..... = M = 0 00691 feet. Probable error per mile..... =  $\hat{M}$  = 0 6745 M = 0 00468 feet.  
 Mean error for whole distance..... =  $\mu$  = 0 08812 feet. Probable error for whole distance..... =  $\hat{\mu}$  = 0 6745  $\mu$  = 0 02571 feet.

V GEODETIC LEVELLING RIVER ST. LAWRENCE Continued 1885-86.  
 Abstract of Results, Station No. 5, St. Antoine de Tilly to St. Joseph de Lévis (Continuous line).

From	To	M. Distance	DIFFERENCE OF HEIGHT			V. Difference from Mean.	2V <sup>2</sup> M.	B. M. W. S. N.T. &c.	Miles.	Feet.	Locality, &c.
			Line A.	Line B.	Mean.						
			Feet.	Feet.	Feet.						
B. M. 146	B. M. 147	0 97.38	0 4579	0 4682	0 4676	0	74	B. M. 146	30 7228	23 7001	Parish of St. Antoine de Tilly B. M. 146 Brass-headed nail on top of elm stump on beach in parish line between St. Genix and St. Antoine.
B. M. 147	B. M. 148	0 4394	1 7867	1 7761	1 7824	7 3	114 64	B. M. 147	20 7475	23 2425	B. M. 147 Brass-headed nail on top of soft maple stump on beach opposite lot No. 247, owned by Benoit Houde.
B. M. 148	B. M. 149	0 5670	1 6856	1 6887	1 6846	0	2 80	B. M. 148	28 8100	21 4001	B. M. 148 Brass-headed nail on root of large soft maple tree on beach back of Cape Aug. Ber- geron's house, west side of wharf.
B. M. 149	B. M. 149 1/2	0 6872	0 6900	0 7600	0 7655	25 5		B. M. 149 1/2	28 2400	23 1447	B. M. 149 Brass-headed nail on top of stump of white birch tree, foot of hill opposite lot No. 198.
B. M. 149	B. M. 149 1/2	0 6872	0 6900	0 7600	0 7655	25 5		B. M. 149 1/2	27 8127	22 3092	B. M. 149 1/2 Brass-headed nail on root of soft maple tree opposite lot No. 101.
B. M. 149	B. M. 149 1/2	0 6872	0 6900	0 7600	0 7655	25 5		B. M. 149 1/2	27 0230	19 0803	B. M. 149 1/2 Copper plug in soft shale rock, foot of cliff, on beach opposite lot No. 170.
B. M. 149	B. M. 149 1/2	0 6872	0 6900	0 7600	0 7655	25 5		B. M. 149 1/2	26 6001	20 2587	B. M. 149 1/2 Copper plug in shale, foot of cliff, on beach opposite lot No. 92.

B. M. L.III.	B. M. 160	1 0033	+ 1 0046	+ 1 0033	+ 1 0040	+ 7	00	C. H. M. 150	20 5106	23 3437	B. M. 160—Brass headed nail on hemlock stump, on beach, foot of cliff, opposite lot No. 69.
<sup>7</sup> B. M. 160	B. M. L.IV	1 1434	- 1 7307	- 1 7227	- 1 7367	- 4 0	27 90	C. B. M. L.IV	24 3674	20 5100	B. M. L.IV—Copper plug in shale on beach, foot of cliff, about opposite lot No. 48.
B. M. L.IV	B. M. L.V	1 5437	- 0 8448	- 0 8631	- 0 8640	+ 9 1	107 22	C. B. M. L.V	22 8227	19 6620	B. M. L.V—Copper plug in solid rock on beach, a few hundred feet west of Pointe Aubin wharf, and opposite lot No. 4.
B. M. L.V	B. M. 1504	1 7449	+ 18 1066	+ 18 1071	+ 18 1069	- 2	....	C. B. M. 1504	24 5086	37 7689	B. M. 1504—Brass-headed nail on root of cedar tree, foot of François Côté's hill, about opposite lot No. 53.
<i>Parish of St. Nicholas.</i>											
B. M. L.V	B. M. L.VI	0 9112	- 1 1016	- 1 1060	- 1 1048	+ 3 2	22 47	C. B. M. L.VI	21 9125	18 5572	B. M. L.VI—Copper plug in solid rock on beach, foot of cliff, about opposite lot No. 299.
B. M. L.VI	B. M. 151	0 8854	+ 3 0076	+ 3 0030	+ 3 0053	+ 2 3	11 81	C. B. M. 151	21 0171	21 5625	B. M. 151—Brass headed nail on root of cedar stump on beach, foot of cliff, about opposite lot No. 276.
B. M. 151	B. M. 152	0 9080	- 0 0802	- 0 0846	- 0 0824	+ 2 2	10 66	C. B. M. 152	20 1091	21 4901	B. M. 152—Brass-headed nail on root of stump near tall balin of (lilled tree on beach, about opposite lot No. 280.
B. M. 152	B. M. L.VII	0 8406	- 0 6015	- 0 5929	- 0 5972	- 4 3	41 99	C. B. M. L.VII	19 2285	20 8829	B. M. L.VII—Copper plug in solid rock on beach, foot of cliff, opposite lot No. 246.
B. M. L.VII	B. M. L.VIII	1 1924	4 0604	- 4 0704	- 4 0654	+ 5 0	41 94	C. B. M. L.VIII	18 0361	16 8175	B. M. L.VIII—Copper plug in solid rock on beach, foot of cliff, about opposite lot No. 228.
B. M. L.VIII	B. M. L.IX	0 6344	+ 4 8151	+ 4 7904	+ 4 8028	+ 12 4	442 86	C. B. M. L.IX	17 3417	21 6203	B. M. L.IX—Copper plug in solid rock in first point above Rose's wharves, about opposite lot No. 211.
Carried forward		13 8616	- 2 0469	- 2 1127	- 2 0798	+ 32 9	990 79				

## V. GEODETIC LEVELLING—RIVER ST. LAWRENCE—Continued—1885-86.

ABSTRACT of Results, Section No. 5, St. Antoine de Tilly to St. Joseph de Lévis (Continuous line)—Continued.

From		To	M. Distance.		DIFFERENCE OF HEIGHT.				V. Dif- ference from Mean.	$2V^2$ — M.	B. M. W. B. ST., &c.	Distance from Lévis	Graving Dock rd line	Feet.	Locality, &c.
			Miles.	Feet.	Line A. Line B.		Mean.								
					Feet.	Feet.		Feet.							

Brought forward.		13.3816	— 2.0469	— 2.1127	— 2.0798	+ 32.9		999.79		C. B. M. LX	16.0703	27.1158	Parish of St. Nicholas—Con. B. M. LX—Copper plug in solid rock, foot of hill on back road leading from beach to League's hotel.
B. M. LXIX.	B. M. LX	1.2924	+ 5.4834	+ 5.5076	+ 5.4955	— 12.1		231.95					
B. M. LX.	B. M. LXI	0.3401	— 4.8836	— 4.8842	— 4.8839	+ .3		.06		C. M. B. LXI	15.7392	22.2319	B. M. LXI—Copper plug in solid rock on beach, about 200 ft. west of Baker's wharf.
B. M. LXI.	B. M. LXII	1.1168	— 3.9945	— 4.0190	— 4.0068	+ 12.2		266.55		C. B. M. LXII	14.6224	18.2251	B. M. LXII—Copper plug in solid rock on beach, about opposite lot No. 88.
B. M. LXII.	B. M. LXIII	1.1591	— 1.0386	1.0507	1.0446	+ 6.1		64.21		C. B. M. LXIII	13.4633	17.1805	B. M. LXIII—Copper plug in solid rock on beach, a few hundred ft. west of Demers' wharf.
B. M. LXIII	B. M. 153.	1.0742	+ 1.5112	+ 1.4941	+ 1.5027	+ 8.0		137.70		C. B. M. 153	12.3891	18.6832	B. M. 153—Brass-headed nail on rock, N.W. side of cedar stump 14 ins. in diameter on beach, about opposite lot No. 40.
B. M. 153.	B. M. LXIV.	0.8046	— 5.0700	5.6455	— 5.6578	— 12.3		376.06		C. B. M. LXIV	11.5845	13.0254	B. M. LXIV—Copper plug in solid rock on beach, foot of cliff, opposite lot No. 20.

R.M. LXIV B.M. LXV.	0 88001	+ 9 18570	+ 9 04750	+ 9 98286	+ 0 0	16 36	B. $\odot$ M. LXV	10 48770	22 19780	B.M. LXV—Copper plug in solid rock on beach, foot of cluster of four white birch trees, 40 paces S.E. of Basile's road, from post road to river.
B.M. LXV. B.M. 154.....	0 7375	— 4 9839	— 4 9805	— 4 9822	— 1 7	7 83	B. $\odot$ M. 154	9 9804	18 0158	B.M. 154—Brass-headed nail on rock, N.W. side of ash tree in swamp, a few hundred ft. west of mouth of Chaudière River.
<i>Parish of St. Romuald.</i>										
B.M. 154..... B.M. LXVI..	0 4411	+ 11 5399	+ 11 5187	+ 11 5283	+ 10 6	509 45	B. $\odot$ M. LXVI	9 5193	29 5451	B.M. LXVI—Copper plug in face of cliff of hard sandstone near last abutment of Chaudière (new) iron bridge and in rear of ferryman's house, owned by Hall Bros. & Co.
B.M. LXVI B.M. 155.....	0 7473	— 6 3252	— 6 3118	— 6 3185	— 6 7	120 15	B. $\odot$ M. 155	8 7721	23 2256	B.M. 155—Brass-headed nail in rock, N.W. side of large cluster of elm trees in Hugh Ritchie's garden, east side of post road.
B.M. 155..... B.M. 156.....	0 8208	— 3 9883	+ 3 9862	+ 3 9873	+ 1 1	2 95	B. $\odot$ M. 156	7 9513	27 2139	B.M. 156—Brass-headed nail on large elm stump, alongside of large elm tree, in Benson's yard on beach N.W. side of post road.
B.M. 155..... B.M. LXVII.	0 9802	+ 12 3310	+ 12 3276	+ 12 3283	+ 1 7	5 89	B. $\odot$ M. LXVII	7 7919	36 5569	B.M. LXVII—Copper plug in hard sandstone point, east side of road, opposite Benson's large saw-mill.
B.M. LXVII. B.M. 157.....	0 8080	+ 7 2183	+ 7 2322	+ 7 2253	— 6 9	117 84	B. $\odot$ M. 157	6 9839	42 7812	B.M. 157—Brass-headed nail on top of large elm stump in Ferdinand Villeneuve's field, east side of post road.
B.M. 157..... B.M. LXVIII.	1 2524	— 14 4859	— 14 4766	— 14 4813	— 4 7	35 28	B. $\odot$ M. LXVIII	6 7315	28 2999	B.M. LXVIII—Copper plug in spur of cliff of hard sandstone, east side of road from Eitchemin, a few hundred feet below Grand Trunk Ry. crossing.
Carried forward.....	24 9918	+ 4 6328	+ 4 5668	+ 4 5986	+ 33 0	2929 15				



R.M. LXXII/B. M. LXXIII	0.0000	2.0000	+ 8.1	102.04	B. $\odot$ M. LXXII	1.4000	26.0026	B. M. LXXII—Copper plug in hard sandstone rock on beach, east side of I. C. Ry. and about opposite Foisy's house.
B.M. LXXII	1.2842	+ 37.7419	+ 10.3	236.62	B. $\odot$ M. LXXIII	0.1753	63.8241	<i>Parish of St. Joseph de Lévis.</i> B. M. LXXIII—Copper plug in centre of large stone, north face east abutment of I. C. Ry., crossing, opposite graving dock.
B.M. LXXII	1.4500	— 4.4633	+ 6.7	103.72	B. $\odot$ M. LXXIV	0.0000	21.6165	B. M. LXXIV—Copper plug in 2nd altar step, S. W. end of Lévis graving dock.
Totals...	30.7233	— 2.0338	+ 49.9	3576.41				

Section No. 5=30.7233 miles.

Mean error per mile..... =  $M = 0.00736$  feet. Probable error per mile..... =  $\hat{M} = 0.6745 \times M = 0.00496$  feet.Mean error for whole distance. =  $\mu = 0.04080$  do do for whole distance.... =  $\hat{\mu} = 0.6745 \times \mu = 0.02752$  do



B.M. I.	B.M. I.	0 205.6	0 047.0	0 060.0	0 063.4	0 5	310 25	B. $\odot$ M.	13 546.3	20 120	B.M. I. — Base located and used on side of larger elm tree on beach, north side of road behind William Munro's Hotel, centre of New London Cove.
B.M. I. .... R.M.E. ....	1 1780	+ 8 7702	+ 8 7808	+ 8 7830	- 0 8		76 21	B. $\odot$ M.	14 0833	28 9031	B.M.E. — Copper plug in north side of rocky point, about 700 ft. below Point à Pigeon, and a little below the Church of St. Columban of Silvery.
B.M.E. .... R.M.F. ....	1 1501	- 0 3875	- 0 4044	- 0 3840	+ 8 4		110 10	B. $\odot$ M.	15 8334	28 5071	B.M.F. — Copper plug in rock on north side of road, at sharp turn, lower end of Spencer Cove.
QUEBEC CITY.											
B.M.F. .... B.M.G. ....	1 3012	- 4 1888	- 4 1942	- 4 1915	+ 2 7		10 38	B. $\odot$ M.	17 1346	24 3156	B.M.G. — Copper plug in façade of Notre Dame de la Garde stone church, in 3rd course of stone above floor level, between main entrance and side door, north side.
B.M.G. .... B.M.J. ....	1 0018	+ 271 2504	+ 271 2565	+ 271 2535	- 3 1			B. $\odot$ M.	18 1364	295 5691	B.M.J. — Copper plug in chambered stone on east corner of east tower of jail inclosure wall.
B.M.J. .... B.M. ....	0 4364	+ 48 5803	+ 48 5585	+ 48 5699	+ 10 4			B.M. ....	18 5728	344 1890	B.M. .... — This bench mark was made by the Royal Engineers on the east side of Martello Tower, close to St. Louis st.
B.M. .... Zero of Quebec Barometer.	0 3501	- 45 3818	- 45 3806	- 45 3712	+ 10 6			0 of Barometer	18 9229	238 7678	Zero of Barometer used at Quebec City Observatory, back of citadel, near jail.
B.M.G. .... R.M.H. ....	1 1420	+ 6 5801	+ 6 5049	+ 6 5175	+ 12 6		226 62	B. $\odot$ M.	18 2706	30 8331	B.M.H. — Copper plug in stone-quin at north-east angle front on Queen's store on Champlain street, about 3½ ft. above street level.
Carried forward .....											
		7 0256	+ 8 3146	+ 8 2861	+ 19 5		1210 56				



L. M. I.	Zero of gauge.	Zero of Quebec Harbour Commission's gauge, on N.E. face of Commissioners' wharf at Pointe à Carey.					
		25 3143	25 3000	25 3121	2 2	17 14 10 of gauge	10 0831
Tideals	7 4021	22 0314	23 0606	22 0076	28 1	1652 62	

From crossing at Basile's Hill to Pointe à Carey—7.8021 miles.

Mean error per mile . . . . .  $M = 0.0091$  foot.      Probable error per mile . . . . .  $M = 0.6745 M = 0.0081$  foot.  
 "      for whole distance . . . . .  $\mu = 0.0264$  "      "      for whole distance . . . . .  $\mu = 0.6745 \mu = 0.0171$  "

VI GEODETIC LEVELLING RIVER ST. LAWRENCE 1886-87.  
Abstract of Results, Section No. 6, St. Antoine de Tilly to St. Jean Deschillons (Continuous line).

From	To	M Distance	DIFFERENCE OF HEIGHT			V. Diff from Mean	2V <sup>2</sup> M.	B. M. W. M. ST. &c.	Locality, &c.
			Line A.	Line B.	Mean.				
			Feet.	Feet.	Feet.				
B. M. 146.	B. M. 149.	0 8179	0 8723	0 8702	0 8713	1 10	8 8276	B. M. 146.	Parish of Ste. Croix. B. M. 146. Brass-headed nail on top of elm stump on beach foot of cliff, in line between the parishes of Ste. Croix and St. Antoine de Tilly.
B. M. 160.	B. M. 161.	1 0047	0 6206	0 6220	0 6213	1 10	1 8003	B. M. 160.	B. M. 160. Brass-headed nail on root of elm stump on beach foot of cliff, about opposite lot No. 6.
B. M. 160.	B. M. LXXXV.	1 3060	0 6827	0 6107	0 6267	7 0	75 0050	B. M. 161.	B. M. 161. Brass-headed nail on root south-west side of each stump on beach edge of bush, about opposite lot No. 16.
B. M. LXXXV.	B. M. LXXXVI.	2 2503	1 0 0517	1 0 0500	1 0 0509	1 0 0	90 7140	B. M. LXXXV.	B. M. LXXXV. Copper plug in shale on beach foot of cliff, about opposite lot No. 10.
B. M. LXXXVI.	B. M. 102.	1 0752	0 3175	0 3150	0 3163	1 3	3 1492	B. M. LXXXVI.	B. M. LXXXVI. Copper plug in soft rock on beach foot of cliff, about opposite lot No. 53, 2 or 3 hundred feet east of wharf.
								B. M. 102.	B. M. 102. Brass-headed nail on root of large elm tree on beach foot of cliff, about opposite lot No. 111

B. M. 102	B. M. 1004	0 3514	1 7022	1 7006	1 7000	+ 0 8	B. $\odot$ M. 1014.	35 8183	21 1700	B. M. 1014. — Brass headed nail on east north-east side of small elm tree on beach, edge of bush, opposite lot No. 91.
B. M. 1014.	B. M. LXXVI A	0 0725	+ 3 9727	+ 3 9916	+ 3 9822	- 0 4	B. $\odot$ M. LXXVI A.	36 1459	25 1522	B. M. LXXVI. — Copper plug in face of stone, planted about 5 ft. into the ground, and standing about 1 ft. above ground, some 200 ft. east of Ste. Croix wharf.
B. M. 102.	B. M. 163.	1 0605	+ 0 3821	+ 0 3787	+ 0 3804	+ 1 7	B. $\odot$ M. 163.	37 2502	23 3054	B. M. 163. — Brass-headed nail on root west side of butternut tree on beach, edge of bush, about opposite lot No. 150.
B. M. 163.	B. M. 164.	0 6801	- 0 0686	- 0 0468	- 0 0527	- 5 9	B. $\odot$ M. 164.	37 9303	23 2567	B. M. 164. — Brass-headed nail on top of small ash stump on beach edge of bush, about opposite lot No. 160.
B. M. 164.	B. M. 165.	1 5292	+ 1 3766	+ 1 3879	+ 1 3873	- 10 6	B. $\odot$ M. P. $\odot$ M. 165	39 4545	24 6440	B. M. 165. — Brass-headed nail in crooked trunk of maple tree on beach edge of bush, about opposite lot No. 179.
B. M. 165.	B. M. 166.	1 3407	- 1 9442	- 1 9697	- 1 9570	+ 12 7	B. $\odot$ M. 166	40 8002	22 6870	B. M. 166. — Brass-headed nail on root east side of large elm tree on beach edge of bush, opposite lot No. 191.
B. M. 166.	B. M. 167.	0 9849	+ 3 1136	+ 3 1216	+ 3 1176	- 4 0	B. $\odot$ M. 167	41 7351	25 8046	B. M. 167. — Brass-headed nail on root west side of butternut stump, on beach edge of bush foot of hill.
B. M. 167.	B. M. 168.	0 6869	- 1 7917	- 1 7818	- 1 7868	- 5 0	B. $\odot$ M. 168	42 4220	24 0178	B. M. 168. — Brass-headed nail on top of snubbing post on beach, east side of Platon wharf.
B. M. 168.	B. M. LXXXVII A	0 1364	+ 11 8507	+ 11 8466	+ 11 8487	+ 2 1	B. $\odot$ M. LXXXVII A	42 5334	35 8665	B. M. LXXXVII — Copper plug in A face of stone monument planted some 5 feet into the ground, with head one foot or so above, opposite Hon. H. G. Joly de Lotbinière's farm-house, west side of road leading to Point Platon wharf.
Carried forward		11 0118	+ 2 0087	+ 2 1104	+ 2 1045	- 5 9				



B.M. LXXX.	B.M. 169	0 01184	+ 8 19829	+ 8 19670	+ 8 19490	2 0	M 02014	R. $\odot$ M. 169	46 0603	29 5344	B.M. 169—Brass-headed nail in rock S. W. side of limestone tree in gully on beach, foot of cliff, about $\frac{1}{2}$ mile below l'Isle or Richelieu Rapids Island.
B.M. 169	B.M. 170	0 0138	7 1596	- 7 1596	7 1596	+ 0 0	0 0000	B. $\odot$ M. 170	46 0700	22 1752	B.M. 170—Brass-headed nail in rock S. W. side of elm tree in gully on beach, foot of cliff, about $\frac{1}{2}$ mile below Richelieu Island.
B.M. 169	B.M. 171	0 0119	- 3 7971	- 3 7957	- 3 7964	- 1 7	465 7143	B. $\odot$ M. 171	46 0041	25 5394	B.M. 171—Brass-headed nail in rock east side of elm tree in gully on beach, about $\frac{1}{2}$ mile east of Richelieu Island.
B.M. 169	B.M. LXXXII.	0 2641	- 10 0289	- 10 0280	- 10 0280	- 1 0	7 5729	B. $\odot$ M. LXXXII	46 3203	19 3088	B.M. LXXXII—Copper plug in solid rock on beach, foot of cliff, opposite Richelieu Rapids Island.
B.M. LXXXII	B.M. LXXXIII	0 5386	+ 1 7028	+ 1 7174	+ 1 7101	- 7 3	197 8834	B. $\odot$ M. LXXXIII	46 8589	21 0159	B.M. LXXXIII—Copper plug in large flat boulder, some 15 feet north of lighthouse on Richelieu Rapids Island.
B.M. LXXXII	B.M. 172	0 2985	+ 4 1212	+ 4 1161	+ 4 1187	+ 2 6	45 2831	B. $\odot$ M. 172	46 6188	23 4245	B.M. 172—Brass-headed nail on top of large elm stump, S. E. side of small brook on beach, opposite upper end of R. R. Island.
B.M. LXXXII	B.M. 173	0 9433	+ 8 8721	+ 8 8769	+ 8 8745	- 2 4	12 2124	B. $\odot$ M. 173	47 2836	28 1803	B.M. 173—Brass-headed nail on top of round ash stump, foot of cliff, in fence line between Pierre Lenay and Hospice Auger.
B.M. 173	B.M. 174	0 5040	+ 6 8681	+ 6 8784	+ 6 8733	5 1	102 2004	B. $\odot$ M. 174	47 7726	35 0636	B.M. 174—Brass-headed nail in rock east side of ash tree at foot of farm road, one mile below Lotbinière parish church.
B.M. 174	B.M. 175	0 5800	- 2 4181	- 2 4249	- 2 4215	+ 3 4	38 8621	B. $\odot$ M. 175	48 3026	32 6321	B.M. 175—Brass-headed nail in rock west side of butternut tree near fence, about $\frac{1}{2}$ mile below church.
Carried forward		17 6293	+ 8 9200	+ 8 9439	+ 8 9320	- 11 9	828 4889				

## VI. GEODETIC LEVELLING, RIVER ST. LAWRENCE. Continued 1885-86.

Abstract of Results, Section No. 6, St. Antoine de Tilly to St. Jean Deschillons (Continuous line) Continued.

T <sub>1</sub>	Distance	Difference of Height				V Difference from Mean	2 V <sup>2</sup> M.	B. M. W. N. ST. E.	Miles.	Feet.	Locality, &c.
		Line A	Line B	Mean	Feet.	Feet.					
Brought forward	17 0253	8 9200	8 9320	8 9260	11 0	828 4860					Parish of St. Louis de Lathinière (Continued).
B. M. 176	0 4361	2 3608	2 3671	2 3639	+ 0 6			B. M. 176A	48 7007	30 2350	B. M. 176A. Brass headed nail in root of large poplar tree, edge of brook, opposite parish church.
B. M. 176	0 0853	0 9203	0 9330	0 9266	8 6	44 4360		B. M. 176A	48 0850	105 6321	B. M. 176A. Copper plug in south west corner of founda- tion of Lathinière parish church.
B. M. 176	0 7078	11 2636	11 2662	11 2644	+ 2 8	22 1681		B. M. 176A	40 0804	21 3367	B. M. 176A. Copper plug in shaly rock near break, foot of cliff, about 1 mile west of parish church.
B. M. 176	0 6366	0 5710	0 5680	0 5695	0 5	104 0180		B. M. 176A	40 8002	20 7712	B. M. 176A. Copper plug in shaly rock about 25 ft. north east of stream from J. W. La liberté's saw mill.
B. M. 176	0 0180	0 8354	0 8546	0 8450	+ 0 4	103 6007		B. M. 176	60 8002	20 2200	B. M. 176. Brass headed nail in rock of bentelm on beach, foot of cliff, about 1 mile west of wharf of Veuille, Egles.

B.M. 176.	B.M. 177.	0 7510	+ 0 3705	+ 0 3707	+ 0 3736	+ 2 0	22 3740	C. M. 177	51 5008	20 5006	B.M. 177.—Brass-headed nail on root north side of elm tree in bush along beach, about 2 miles below Ste. Emmélie church.
B.M. 177.	B.M. 178.	0 9083	+ 5 7062	+ 5 7067	+ 5 7610	+ 5 3	58 5635	C. M. 178	52 5201	26 3606	B.M. 178.—Brass-headed nail in root south-east side of white birch tree, some 25 ft. up cliff, about one mile below church of Ste. Emmélie.
B.M. 178.	B.M. 179.	1 3508	— 1 5568	— 1 5626	— 1 5607	+ 2 9	12 3686	C. M. 179	53 8799	24 8009	<i>Parish of Ste. Emmélie.</i> B.M. 179.—Brass-headed nail in root south west side of butter-nut tree on beach, on west bank, mouth of Grande Rivière du Chêne.
B.M. 179.	B.M. LXXXVII.	0 1949	+ 13 7813	+ 13 7794	+ 13 7804	+ 1 0	10 2616	C. M. LXXXVII	54 0745	38 5813	B.M. LXXXVII.—Copper plug in stone foundation east side of Damase Beaudet's brick house, village of Leclercville, foot of hill leading to Ste. Emmélie parish church.
B.M. 179.	B.M. LXXXVIII.	0 3400	+ 74 9792	+ 74 9809	+ 74 9846	— 5 3	165 2353	C. M. LXXXVIII	54 2199	98 7855	B.M. LXXXVIII.—Copper plug in east side stone foundation, under tower and spire of parish church of Ste. Emmélie (brick).
B.M. 179.	B.M. 180.	0 3760	+ 17 9032	+ 17 9105	+ 17 9078	— 2 7	38 7766	C. M. 180	54 2559	42 7067	B.M. 180.—Brass-headed nail in root north east side of white birch tree, some 30 ft. up cliff, north side of gully, $\frac{1}{2}$ mile west of Grande Rivière du Chêne.
B.M. 180.	B.M. 181.	1 6883	— 15 0804	— 15 0750	— 15 0777	— 2 7	8 6359	C. M. 181	55 9442	27 6810	B.M. 181.—Brass-headed nail in root north-west side of Balm of Gilead tree, along cliff, about $\frac{1}{4}$ mile below Petite Rivière du Chêne.
Carried forward.		25 2209	+ 3 9304	+ 3 9314	+ 3 9309	— 0 5	1282 9400				

## VI—GEODETIC LEVELLING—RIVER ST, LAWRENCE—1886-87—Concluded.

ABSTRACT of Results, Section No. 6, St. Antoine de Tilly to St. Jean Deschailhons (Continuous line)—Concluded.

From	To	M. Distance.	DIFFERENCE OF HEIGHT.		V. Differ- ence from Mean.	$\frac{2 V^2}{M}$	B. M. W. S. ST., &c.	Distance from Levis Dock rd line of levels.	Miles.	Feet.	Locality, &c.
			Line A, ←	Line B, →							
		Miles.	Feet.	Feet.	Feet.	1000					
Brought forward.		25 2269	+ 3 9304	+ 3 9314	+ 3 9309	- 0 5	1282 9400				
B. M. 181.	B. M. LXXXIX	0 2571	= 1 1879	= 1 1923	= 1 1901	+ 2 2	40 8266		56 1813	26 4409	Parish of Ste. Emmilie—Con. B. M. LXXXIX—Copper plug in stone foundation west side of Louis Lafond's wooden house at mouth of Petite Riviere du Chene.
Totals.		25 4580	+ 2 7425	+ 2 7391	+ 2 7408	+ 1 7	1323 7666				

B. M. 146 to B. M. LXXXIX = 25 4580 miles.

Mean error per mile ..... M = 0 00304 feet.  
 " for whole distance ..... μ = 0 02546 "

Probable error per mile ..... M = 0 0745 M = 0 00340 feet.  
 " for whole distance ..... μ = 0 0745 μ = 0 01717 "

From	To	DIFFERENCE OF HEIGHT.				$\frac{2V^2}{M}$	B. M. W. S. ST. &c.	Distance from Levy's Graving Dock line of levels.	Elevation, above + below level, Atlantic Ocean, by R. Steckel, 1880-82.	Locality, &c.
		M. Distance.	Line A. Line B.		V. Difference from Mean.					
			Line A.	Line B.	Mean.					
		Miles.	Feet.	Feet.	Feet.	Feet.		Miles.	Feet.	
						$\frac{\text{Feet.}}{1000}$				
										<i>Parish de la Nativité de Bécancour.</i>
B.M. NC...	B.M. 182.....	0.2025	— 0.1554	— 0.1535	— 0.1545	— 1.0	B. M. C. M. XC	80.7841	33.4704	B.M. XC.—Copper plug in stone foundation of L. Provencher's wooden house, west side of Post Road, a few hundred feet west of parish line between Gently and Bécancour.
B.M. XC...	B.M. XCI...	0.4010	+ 3.4101	+ 3.4118	+ 3.4110	— 0.8	B. M. C. M. 182	80.9866	33.3159	B.M. 182.—Brass-headed nail on root of large elm tree in Godfroi Carignan's field, north side of Post Road.
B.M. XCI	B.M. 182½...	1.1563	— 9.0909	— 9.1218	— 9.1064	+ 15.4	B. M. C. M. 182½	81.1581	36.8814	B.M. XCI.—Copper plug in north-east side of stone foundation of Moise Genest's house, on south side of Post Road.
								82.3414	27.7750	B.M. 182½.—Brass-headed nail on root of small oak tree at junction of route from new road with old road on Clovis Boisvert's property, lot No. 41.
B.M. 182½	B.M. 182½...	0.5175	— 2.2734	— 2.2645	— 2.2690	— 4.5	B. M. C. M. 182½	82.8589	25.5060	B.M. 182½.—Brass-headed nail on top of small elm stump on beach, foot of long route, opposite lot No. 40.
Carried forward.....		0.4010	+ 3.4101	+ 3.4118	+ 3.4110	— 0.8			3.1920	


VII GEODETIC LEVELLING RIVER ST. LAWRENCE 1886-87 Continued.  
 Abstract of Results, Section No. 7, Bécancour to La Baie du Pebyre (Continuous line) Continued.

DIFFERENCE OF HEIGHT.										Locality, &c.			
From	To	M Distance.		A Line B. Line A.		Mean.	V. Differ- ence from Mean.	$\frac{2V^2}{M}$	B. M. W. N. &c.	Distance from Graving Dock Levis	Miles.	Feet.	Elevation, above + below level, Atlantic Ocean, established at Quebec by R. Seckel, 1880-82.
		Miles.	Feet.	Feet.	Feet.								
Brought forward		0 4010	+ 3 4101	+ 3 4118	+ 3 4110		0 8	3 1020	C	82 0701		42 6107	Parish de la Nativité de Bécancour Continued.
B. M. XCI	B. M. XCII.	0 8040	+ 5 7220	+ 5 7297	+ 5 7218		4	3870	B. M. XCII				B. M. XCII--Copper plug in stone foundation, south face of Ferdinand Leblanc's wooden house on north side of Post Road.
B. M. XCII.	B. M. XCIII.	0 8347	3 2420	3 2617	3 2528	+ 0 4		211 7107	C	82 0138		30 3684	B. M. XCIII Copper plug in stone basement, north face of Louis Masse's wooden house on north side of Post Road.
B. M. XCIII	B. M. 183	1 2823	0 0090	0 0086	0 0088	0 2		0024	C	84 1061		30 2016	B. M. 183 Brass-headed nail on root, west side of large bitter-nut tree, Lot No. 106, on east side of road, about 6 feet from junction of old road with road to Ste. Angèle.
B. M. 183	B. M. 184	0 5205	0 0724	0 0681	0 0708	0 2		18 2814	C	84 7256		30 1013	B. M. 184 Brass-headed nail on top of large elm stump in David Mayrand's field, south-east side of Post Road.
B. M. 184	B. M. 185	0 5080	5 0483	5 0307	5 0425	5 4		132 0905	B. M. 185	85 2815		25 1488	B. M. 185--Brass-headed nail in root, east side of large soft maple tree on N. W. bank of River Bécancour, north side of bridge.

B.M.	186	B.M. XCIX.	1 0673	+ 14 9323	+ 14 9302	+ 14 9373	1 0	6 0403	B. $\odot$ M. XCIX	86 3188	44 0941	B.M. XCIX. Copper plug in top course of stone basement of new Roman Catholic church on east side of Post Road.
B.M. 185	B.M. 186		0 7898	+ 1 5106	+ 1 6283	+ 1 5170	- 6 3	100 0339	B. $\odot$ M. 186	86 0213	26 0458	B.M. 185. Brass-headed nail in root of large oak tree about 150 feet east of roadway at sharp turn of road, lot No. 529.
B.M. 186	B.M. XCIV.		1 2406	+ 6 9434	+ 6 9242	+ 6 9338	+ 9 6	140 2619	B. $\odot$ M. XCIV	87 2609	33 5906	<i>Parish of St. Angele de Laval.</i> B.M. XCIV.—Copper plug in stone-wall, under sill of first window, east side of front door in Clovis Tourigny's stone house, on lot No. 6.
B.M. XCIV	B.M. 187		1 1781	- 1 2928	- 1 2506	- 1 2712	- 11 6	228 4365	B. $\odot$ M. 187	88 4380	32 3284	B.M. 187.—Brass-headed nail on root, north-west side of large ash tree, on south side of road, opposite centre of lot No. 21, or thereabouts.
B.M. 187	B.M. XCV.		0 6903	+ 3 1139	+ 3 1055	+ 3 1097	+ 4 2	51 1082	B. $\odot$ M. XCV	89 1293	35 4381	B.M. XCV.—Copper plug in stone basement of Honore Lenne- ville's house on lot No. 32, south side of Post Road.
B.M. XCV	B.M. XCVI.		1 0053	+ 5 4897	+ 5 5005	+ 5 4951	- 5 4	58 0125	B. $\odot$ M. XCVI	90 1346	40 9332	B.M. XCVI.—Copper plug in stone front, north side of main entrance to Roman Catholic Church, south-east side of Post Road.
B.M. XCVI	B.M. 188		0 9302	- 3 9180	- 3 9471	- 3 9326	+ 14 5	452 0533	B. $\odot$ M. 188	91 0648	37 0006	B.M. 188.—Brass-headed nail in root south side of large pine tree lot No. 137, on north side of Post Road, opposite William Patterson's house.
B.M. 188	B.M. 189		1 1742	- 11 0138	- 10 9900	- 11 0019	- 11 9	241 2026	B. $\odot$ M. 189	92 2390	25 9487	<i>Parish of St. Gregoire.</i> B.M. 189.—Brass-headed nail in root, south-west side of ash tree in field on lot No. 13, south side of Post Road.
Carried forward....			11 4549	- 7 4784	- 7 4648	- 7 4717	- 6 9	1647 3098				

VII ALLOMETRIC LEVELLING RIVER ST. LAWRENCE 1886-87 Continued.

Abstract of Results, Section No. 7, Bécanour to La Baie du Febvre (Continuous line) Continued.

Sta.	To	M. Distance	DIFFERENCE OF HEIGHT.				V. Difference from Mean.	2V <sup>2</sup> M.	B. M. W. S. E. &c.	Feet. Miles.	Feet.	Locality, &c.	
			Line A.	Line B	Mean.								
													
Brought forward													
B. M. 100	B. M. 100	0 449	7 4784	7 4948	7 4717	6 9	1047 8000	C	B. M. 100	92 2707	80 4108	B. M. 100. Top of stone planted by D. C. Morency, D. L. S. at request of Crown Lands Department, Quebec, on lot No. 86 on west side of Road.	
B. M. 100	B. M. 101	0 0863	0 0020	0 1205	0 1072	13 3	308 0031	C	B. M. 101	08 7570	34 3085	B. M. 101. Brass-headed nail in root of small elm tree, Lot No. 86, on west side of Post Road, at its intersection with cross road to Nicolet.	
B. M. 101	B. M. XCVII	0 4834	1 4738	1 4043	1 4080	4 7	01 3045	C	B. M. XCVII	04 2404	35 7780	B. M. XCVII. Copper plug in north east wall of Napoleon Poirier's stone house on lot No. 50 south side of old main road.	
B. M. XCVII	B. M. 102	0 1023	0 0166	0 0840	0 0208	1 1	221 8005	C	B. M. 102	04 6326	20 7438	B. M. 102. Brass headed nail in root south side of white oak tree on Lot No. 86, Napoleon Poirier's property, north side of Post Road.	
B. M. 102	B. M. XCVIII	0 0700	1 7 4475	1 7 4418	1 7 4444	3 1	10 0027	C	B. M. XCVIII	05 8085	37 1082	B. M. XCVIII. Copper plug, south wall of Beaulieu Poirier's stone house on Lot No. 76 north west side of road.	

B.M. XCVIII B. M. 1188	1 0657	0 47 44	0 4021	0 4065	0 4	76 4057	B. $\odot$ M. 1188	98 4012	30 7217	B. M. 1187. Brass-headed nail in root south-west side of large elm tree on Lot No. 100 north side of Post Road.
										<i>Parish of St. Jean Baptiste de Nicolet.</i>
B. M. 193. . . . . B. M. 194. . . . .	1 2886	+ 6 0351	+ 6 0043	+ 6 0222	+ 12 9	268 2703	B. $\odot$ M. 194	98 1828	36 7439	B. M. 194. - Brass-headed nail in root north-west side of large elm tree on lot No. 16, Mrs. Bernard Cecile's property; close to fence south side of road.
B. M. 194. . . . . B. M. 196. . . . .	0 4612	+ 10 2170	+ 10 2075	+ 10 2123	+ 4 8	96 7606	B. $\odot$ M. 196	98 6640	26 5316	B. M. 196—Brass-headed nail in root of large soft maple tree (north-west side) near beach, north-east side of road to wharf of Port St. Francis.
B. M. 194. . . . . B. M. C. . . . .	0 1726	+ 3 3890	+ 3 3033	+ 3 3012	- 2 1	51 1008	B. $\odot$ M. C	98 3554	40 1351	B. M. C—Copper plug in north-east gable of Antoine Brassard's stone house, west side of post road.
B. M. 194. . . . . B. M. 196. . . . .	1 2044	- 3 8475	- 3 8542	- 3 8508	+ 3 4	19 1963	B. $\odot$ M. 196	99 3872	32 8931	B. M. 196—Brass-headed nail in top of large soft maple stump in field, west side of post road, lot No. 381.
B. M. 196. . . . . B. M. 197. . . . .	1 2140	+ 2 3424	+ 2 3322	+ 2 3373	+ 5 1	42 8501	B. $\odot$ M. 197	100 6012	36 2304	B. M. 197—Brass-headed nail in root north-east side of large elm tree, west side of post road, on Gideon Brassard's property, lot No. 381.
B. M. 197. . . . . B. M. CI. . . . .	0 6763	+ 13 3313	+ 13 3228	+ 13 3270	+ 4 2	52 1662	B. $\odot$ M. CI	101 2775	48 5574	B. M. CI—Copper plug in south wall of Antoine Beaubien's stone house on north side of post road, and opposite lower crossing of Nicolet River.
B. M. CI. . . . . B. M. 198. . . . .	0 6496	+ 3 8024	+ 3 8028	+ 3 8026	- 2	1232	B. $\odot$ M. 198	101 9271	52 3600	B. M. 198. Brass-headed nail on top of large red oak stump in field, south side of post road.
Carried forward. . . . .	20 4934	+ 15 1246	+ 15 0497	+ 15 0870	+ 37 3	2832 4602				

## VII GEODETIC LEVELLING RIVER ST. LAWRENCE 1886-87 Continued.

Abstract of Results, Section No. 7, Éclaircissement de la Baie du Felyre (Continuous line) Continued.

To	M. Distance.	Difference of Height.				V. Differ- ence from Mean.	2√2 M.	B. M. W. B. ST. &c.	Miles.	Feet.	Locality, &c.
		Low A	High B.	Mean.	Feet.						
	Miles	Feet.	Feet.	Feet.	Feet.						
Brought forward	20 4254	+ 16 1246	+ 16 0497	+ 16 0870	+ 37 8	2862 0002					Parish of St. Jean Bte. de Noellet.
B. M. 190. B. M. C'II.	0 44.4	+ 22 6161	+ 22 6111	+ 22 6136	+ 2 6	20 0647		B. C'II M. 191	102 3726	74 0780	B. M. C'II. Copper plug in north-west corner of Roman Catholic Cathedral (cut stone), town of Noellet.
B. M. C'I	0 4256	21 7943	21 7902	21 7968	4 1	70 4007		B. C'II M. 190	101 7010	20 7071	B. M. 190. Brass-headed nail in root north side of small elm tree on bench south landing of lower ferry across River Ni Noellet.
B. M. C'I	0 80380	0 0462	0 0450	0 0466	1 6	6 0260		B. C'II M. 191	102 1414	48 6106	B. M. C'II. Copper plug in north-east corner of Quai de Brasserie's stone house on lot No. 510 at junction of lower ferry route and main road.
B. M. C'III	0 8024	14 8719	14 8667	14 8765	+ 7 2	116 1811		B. C'II M. 200	103 0308	38 0823	B. M. 200. Brass headed nail in root of soft maple tree on lot No. 510, east side of road and about 30 feet south of school house.
B. M. 200. ....	0 7134	+ 1 1476	+ 1 1000	+ 1 1543	0 6	122 1104		B. C'II M. 201	103 7472	34 7806	B. M. 201. Brass-headed nail in root, north-west side of white oak tree, on lot No. 520, east side of post road.

B.M. 201.	B.M. 202.	1 02562	+ 4 80824	+ 4 80826	+ 4 80831	4	3100	B. $\odot$ M. 202	104 7704	39 0487	B.M. 203	Brass headed nail in root, west side of small elm tree, east side of post road, on lot No. 561, owned by Herbert Dugway.
B.M. 202.	B.M. CIV.	0 4075	+ 6 4024	+ 6 8043	+ 6 8044	4 1	71 9146	B. $\odot$ CIV	105 2430	46 5081	B.M. CIV.	Copper plug in stone of foundation under gallery, west side of steps leading up to front door of Jean Rousseau's house, east side of post road.
B.M. CIV.	B.M. CV.	0 4746	- 8 3063	- 8 3083	- 8 3023	4 0	32 7008	B. $\odot$ CV	106 2225	38 1738	B.M. CV.	Copper plug in stone foundation, front of William Houle's house, east side of post road.
B.M. CV.	B.M. CVI.	1 1480	- 0 2002	- 0 2078	- 0 2040	3 8	25 1569	B. $\odot$ CVI	107 3706	37 9718	B.M. CVI.	Copper plug in stone foundation of Anselme Lafond's house, north-west side of post road.
B.M. CVI.	B.M. CVII.	1 0235	+ 6 1397	+ 6 1378	+ 6 1387	9	1 5829	B. $\odot$ CVII	108 3040	44 1105	B.M. CVII.	Copper plug in stone foundation of Edward Leniers's house, on east side of post road, lot No. 427.
B.M. CVII.	B.M. 203.	1 1310	- 4 6364	- 4 6115	- 4 6239	12 4	271 9010	B. $\odot$ M. 203	109 7250	39 4946	B.M. 203.	Brass-headed nail in root, north-west side of hickory tree on lot No. 459, Frs. Futra's property, east side of post road.
B.M. 203.	B.M. LI.	0 8042	+ 8 9823	+ 8 9837	+ 8 9830	7	1 2186	B. $\odot$ LI	110 3292	48 4036	B.M. LI.	Copper plug in eastern wall of stone basement of Nestor Dugway's store, foot of hill leading to parish church of St. Antoine de la Baie du Febvre.
T-cash.		29 5451	+ 15 0270	+ 14 9716	+ 14 9692	27 6	3501 9730					

Section No. 7 = 29.5451 miles.

Mean error per mile	....	- M = 0.00729 feet	Probable error per mile	....	M = 0.00492 feet.
	....			....	

Mean error for whole distance.....  $\mu = 0.03859$  feet. Probable error for whole distance.....  $\mu = 0.0745$   $\mu = 0.02570$  feet.

... of ... ..

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Locality, &c.

Miles. Feet.

*Parish of de la Nativité de Béancour.*

B.M. XC. Copper plug in stone foundation of L. Provencher's wooden house, west side of post road, some 300 ft. west of parish line between Gentilly and Béancour.

*Parish of St. Edouard de Gentilly.*

B.M. CXVII - Copper plug in stone foundation of P. Reault's wooden house on west side of post road.

B.M. 204 - Brass-headed nail on top of pier of new bridge over Gentilly River, eastside of post road.

B.M. CVIII - Copper plug in stone basement of Landier's wooden house on east side of post road.

B.M. CIX - Copper plug in south-east corner of stone basement of Joseph Landier's wooden house, west side of post road.

B. C. M.  
X

7041

23 4704

B. C. M.  
CXVII

70 8470

31 9782

B. C. M.  
204

70 2787

31 9700

B. C. M.  
CVIII

78 1084

44 0848

B. C. M.  
CIX

77 3413

37 4020

B.M. CIX.	B.M. 206	1 4915	10 2062	10 2600	10 2601	0 0	44 3020	B. $\odot$ M. 206	75 0428	27 0014	B.M. 206—Brass-headed nail in root of small ash tree on beach foot of old church road, and opposite the property of Hector Turrot, about 80 ft. from high water mark.
B.M. CIX.	B.M. CX.	1 5001	+ 32 0744	+ 32 1042	+ 32 0803	14 9	279 2403	B. $\odot$ M. CX	75 7592	69 1813	B.M. CX—Copper plug on 2nd lowest stone quoin, south-east corner of Roman Catholic parish church, on west side of post road.
B.M. CX.	B.M. 205½	0 5019	— 48 1622	— 48 1403	— 48 1513	11 0	430 6818	B. $\odot$ M. 205½	75 1973	21 8390	B.M. 205½—Brass-headed nail on top of remains of small baln of Gilead tree, foot of road leading from Gentilly church to beach.
B.M. CX.	B.M. 206	1 2062	+ 7 6207	+ 7 6340	+ 7 6274	6 6	72 2268	B. $\odot$ M. 206	74 5530	77 6067	B.M. 206—Brass-headed nail in root of small white birch tree in Ludger Mailhot's field, east side of post road.
B.M. 206	B.M. CXI	0 7027	56 0607	— 56 0604	— 56 0651	4 3	52 6256	B. $\odot$ M. CXI	73 8503	21 5436	B.M. CXI—Copper plug in large flat stone, embedded in south bank of Rivière du Moulin, near its mouth.
B.M. CXI	B.M. 207	1 1232	9 5115	+ 9 5363	+ 9 5234	11 9	252 1546	B. $\odot$ M. 207	72 7271	31 0670	B.M. 207—Brass-headed nail on root, north side of large elm tree in field, about 300 ft. from high water mark, opposite lot No. 33
B.M. 207	B.M. 208	1 1639	6 2903	6 3147	— 6 3070	7 7	107 4192	B. $\odot$ M. 208	71 6232	24 7000	B.M. 208—Brass-headed nail on root, west side of baln of Gilead tree on north side of mouth of Rivière aux Originaux, opposite lot No. 1.
B.M. 208	B.M. 209	1 0684	+ 6 6752	+ 6 6825	+ 6 6789	3 6	24 2006	B. $\odot$ M. 209	70 5548	31 4380	B.M. 209—Brass-headed nail on root, south-west side of white pine tree, foot of high cliff and opposite lot No. 153.
Carried forward		10 2203	— 2 0640	— 1 0602	— 2 0315	32 3	803 2684				<i>Parish of St. Pierre les Beccquets.</i>



B.M. 212.	B.M. 213.	0 8011	3 6840	3 6990	3 8018	+ 7.2	121 8180	C. $\odot$ M. 213	21 8170	R.M. 213—Brass-headed nail on rock, west side of large balm of Gilead tree on beach, foot of cliff, opposite lot No. 88.
B.M. 213.	B.M. 214.	0 9613	2 1820	2 1742	2 1781	+ 3.9	31 9773	C. $\odot$ M. 214	23 9981	R.M. 214—Brass-headed nail on root of large balm of Gilead tree on beach, foot of cliff, opposite lot No. 9.
B.M. 214.	B.M. CXIV.	0 7817	1 4355	1 4250	1 4303	+ 5.3	71 8690	C. $\odot$ M. CXIV	64 9028	Parish of St. Jean Deschailhons.
B.M. CXIV	B.M. 215.	0 8885	6 2472	6 2235	6 2353	+ 11.8	313 4271	C. $\odot$ M. 215	63 1326	R.M. 215—Brass-headed nail on root of small stump on beach, west side of route leading up to post road.
B.M. 215.	B.M. 216.	1 0822	0 7798	0 9579	0 9689	— 11.0	223 6187	C. $\odot$ M. 216	62 0504	R.M. 216—Brass-headed nail on west side of root of large elm tree, opposite lot No. 76.
B.M. 216.	B.M. 217.	0 6307	5 0408	5 0298	5 0353	— 5.5	95 9252	C. $\odot$ M. 217	61 4197	R.M. 217—Brass-headed nail on root of small balm of Gilead tree, on beach foot of cliff, opposite lot No. 96.
B.M. 217.	B.M. CXV.	0 7165	2 0332	2 0391	2 0316	— 1.5	6 2719	C. $\odot$ M. CXV	60 7032	R.M. CXV—Copper plug in immense boulder, on beach foot of cliff, opposite lot No. 125. In the fall of 1888 this bench had sunk down to 23 5349.
B.M. CXV.	B.M. 218.	0 2686	58 7816	58 7697	58 7562	— 4.5	135 6364	C. $\odot$ M. 118	60 4046	R.M. 218—Brass-headed nail on root of soft maple tree, west side of plateau, half-way up wharf hill. In 1888, on account of the sliding of the cliff in the spring, this bench had descended to 81 8287.
B.M. CXV.	B.M. CXVI.	0 4904	136 3965	136 4090	136 4028	— 6.2	156 7699	C. $\odot$ M. CXVI	60 2128	R.M. CXVI—Copper plug in stone basement, north-west corner of parish church, St. Jean des Chailhons, some 4 feet above ground.
Carried forward		20 0809	— 9 8337	— 9 8374	— 9 8455	— 8.1	2065 6261		160 0277	



Section Nos. 8 24 00288 miles

Mean error per mile	$M = 0.00050$ ft.	Probable error per mile	$\bar{M} = 0.6745 M = 0.00439$
Mean error for whole distance	$\mu = 0.03223$ ft.	Probable error for whole distance	$\bar{\mu} = 0.6745 \mu = 0.02174$

### Abstract of Results, Section No 2, Sord to Yermures (Continuous line)

[illegible]

B.M. XXVI	0.3779	-6.7774	6.7612	-6.7603	8.10	847.2340	B. $\odot$ M. XXIV	141.4800	46.3641	Copper plug in stone basement of Sorel market hall, 21 feet east of south-east corner, and about 34 feet above ground.
B.M. CXXIV B.M. 229	0.3762	+8.2854	+8.2815	+8.2835	+2.60	21.2653	B. $\odot$ M. CXXIV	141.8130	39.5848	Copper plug in brick wall, about 3 feet above ground under gallery at north-west corner of Messrs. McCarthy's brick house, south side of post road.
B.M. 229 B.M. 230	0.8027	-0.7701	-0.7561	-0.7631	-7.00	122.0879	B. $\odot$ M. 229	142.1901	47.8083	Brass-headed nail on top of small pine stump near post road fence, opposite Wm. Nolan's farm.
B.M. 230 B.M. 231	1.0134	-5.8391	-5.8202	-5.8297	-9.50	178.1133	B. $\odot$ M. 231	142.9928	47.1052	Brass-headed nail on top of small white birch stump, in field on north side of post road at end of long bush where road turns to follow the River St. Lawrence.
B.M. 231 B.M. CXXV	0.2914	+1.7636	+1.7615	+1.7626	+1.10	8.3047	B. $\odot$ M. CXXV	144.0062	41.2755	Brass-headed nail on root of red spruce tree about 120 feet, south of southern road fence on Xavier Pelouquin's farm, near fence line between Pelouquin and Joly.
B.M. 231 B.M. 232	1.1196	-1.1998	-1.1968	-1.1983	-1.50	4.0193	B. $\odot$ M. 232	144.2976	43.0381	Copper plug in north gable, about 2 feet above ground, of Michel Pelouquin's brick house, on south side of post road.
B.M. 232 B.M. 233	0.7671	-3.2051	-3.2120	-3.2066	+3.40	30.1395	B. $\odot$ M. 233	145.1258	40.0772	Brass-headed nail in root, south-east side of ash tree, in Wilfred Pelouquin's field, south side of post road.
B.M. 233 B.M. CXXVI	0.5836	+9.0147	+9.0236	+9.0192	-4.40	66.3468	B. $\odot$ M. CXXVI	145.8929	36.8636	Brass-headed nail in root, north-west side of ash tree, close to north-east fence of Edouard Blais's farm, 3 feet east of road fence.
Carried forward	5.0405	-0.4914	-0.4412	-0.4663	-25.10	769.2070		146.4765	45.8878	Copper plug in north-east gable of Louis Cartier's story and a-half brick-veneered house, with good stone foundation, on south side of post road.

Received of Mr. J. H. ... \$100.00

Locality, &c.	Year.	1870	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367	2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378	2379	2380	2381	2382	2383	2384	2385	2386	2387	2388	2389	2390	2391	2392	2393	2394	2395	2396	2397	2398	2399	2400	2401	2402	2403	2404	2405	2406	2407	2408	2409	2410	2411	2412	2413	2414	2415	2416	2417	2418	2419	2420	2421	2422	2423	2424	2425	2426	2427	2428	2429	2430	2431	2432	2433	2434	2435	2436	2437	2438	2439	2440	2441	2442	2443	2444	2445	2446	2447	2448	2449	2450	2451	2452	2453	2454	2455	2456	2457	2458	2459	2460	2461	2462	2463	2464	2465	2466	2467	2468	2469	2470	2471	2472	2473	2474	2475	2476	2477	2478	2479	2480	2481	2482	2483	2484	2485	2486	2487	2488	2489	2490	2491	2492	2493	2494	2495	2496	2497	2498	2499	2500	2501	2502	2503	2504	2505	2506	2507	2508	2509	2510	2511	2512	2513	2514	2515	2516	2517	2518	2519	2520	2521	2522	2523	2524	2525	2526	2527	2528	2529	2530	2531	2532	2533	2534	2535	2536	2537	2538	2539	2540	2541	2542	2543	2544	2545	2546	2547	2548	2549	2550	2551	2552	2553	2554	2555	2556	2557	2558	2559	2560	2561	2562	2563	2564	2565	2566	2567	2568	2569	2570	2571	2572	2573	2574	2575	2576	2577	2578	2579	2580	2581	2582	2583	2584	2585	2586	2587	2588	2589	2590	2591	2592	2593	2594	2595	2596	2597	2598	2599	2600	2601	2602	2603	2604	2605	2606	2607	2608	2609	2610	2611	2612	2613	2614	2615	2616	2617	2618	2619	2620	2621	2622	2623	2624	2625	2626	2627	2628	2629	2630	2631	2632	2633	2634	2635	2636	2637	2638	2639	2640	2641	2642	2643	2644	2645	2646	2647	2648	2649	2650	2651	2652	2653	2654	2655	2656	2657	2658	2659	2660	2661	2662	2663	2664	2665	2666	2667	2668	2669	2670	2671	2672	2673	2674	2675	2676	2677	2678	2679	2680	2681	2682	2683	2684	2685	2686	2687	2688	2689	2690	2691	2692	2693	2694	2695	2696	2697	2698	2699	2700	2701	2702	2703	2704	2705	2706	2707	2708	2709	2710	2711	2712	2713	2714	2715	2716	2717	2718	2719	2720	2721	2722	2723	2724	2725	2726	2727	2728	2729	2730	2731	2732	2733	2734	2735	2736	2737	2738	2739	2740	2741	2742	2743	2744	2745	2746	2747	2748	2749	2750	2751	2752	2753	2754	2755	2756	2757	2758	2759	2760	2761	2762	2763	2764	2765	2766	2767	2768	2769	2770	2771	2772	2773	2774	2775	2776	2777	2778	2779	2780	2781	2782	2783	2784	2785	2786	2787	2788	2789	2790	2791	2792	2793	2794	2795	2796	2797	2798	2799	2800	2801	2802	2803	2804	2805	2806	2807	2808	2809	2810	2811	2812	2813	2814	2815	2816	2817	2818	2819	2820	2821	2822	2823	2824	2825	2826	2827	2828	2829	2830	2831	2832	2833	2834	2835	2836	2837	2838	2839	2840	2841	2842	2843	2844	2845	2846	2847	2848	2849	2850	2851	2852	2853	2854	2855	2856	2857	2858	2859	2860	2861	2862	2863	2864	2865	2866	2867	2868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B.M. 236	B.M. 237	1 1254	+ 0 4102	+ 0 4048	+ 0 4074	+ 2 60	11 0876	D. $\odot$ M. 237	161 1006	47 0655	Brass-headed nail in root east side of small elm tree, about 3 feet west of road on Joseph Mainville's property.
B.M. 237	B.M. 238	0 9877	+ 1 0171	+ 1 0182	+ 1 0162	+ 1 00	2 0249	B. $\odot$ M. 238	152 0633	48 0637	Brass-headed nail in root of large ash tree, about 2 feet west of post road fence, opposite M. Duhamel's property.
B.M. 238	B.M. 239	1 2250	+ 2 3413	+ 2 3668	+ 2 3540	-12 80	267 4839	B. $\odot$ M. 239	153 3183	50 4237	Brass-headed nail in root, north-west side of large elm tree on Gilbert Rousseau's land, close to fence, west side of post road.
B.M. 239	B.M. 240	0 7371	+ 5 9885	+ 5 9729	+ 5 9857	+12 80	444 5580	B. $\odot$ M. 240	154 0654	56 4094	Brass-headed nail on top of small willow stump close to Joseph Millet's house on west side of post road.
B.M. 240	B.M. 241	0 9123	+16 3401	+16 3485	+16 3433	- 3 20	22 4487	B. $\odot$ M. 241	154 9877	72 7527	Brass-headed nail in root of small elm tree, on Magloire Fortier's property, one foot inside of fence, east side of post road.
B.M. 241	B.M. 242	0 3991	- 0 9462	- 0 9444	- 0 9453	- 90	4 0590	B. $\odot$ M. 242	155 3668	71 8074	Small cavity on top of boundary stone at west end of St. Ours Seignior, west side of post road, on Louis Millot's property.
B.M. 242	B.M. 243	0 7740	-23 5941	-23 6068	-23 6015	+ 7 30	137 5711	B. $\odot$ M. 243	156 1408	48 2059	Brass-headed nail in root, north-east side of large elm tree, east side of post road, on Joseph Lamoureux's property.
B.M. 243	B.M. CXXVIII	0 6621	+ 1 1584	+ 1 1640	+ 1 1612	- 2 80	23 6822	B. $\odot$ M. CXXVIII	156 8029	49 3671	Copper plug in stone foundation (S.W. corner) of Jos. Dione's story and a-half brick house, on east side of post road.
B.M. CXXVIII	B.M. CXXIX	0 8191	+ 0 8270	+ 0 8049	+ 0 8160	+11 10	300 8424	B. $\odot$ M. CXXIX	157 6220	50 1831	Copper plug on lower stone course, 13 inches above steps, north corner of Contrecoeur church front, on east side of post road.
Brought forward		16 1860	+ 3 8297	+ 3 8283	+ 3 8260	+ 0 70	2243 4930				



B. M. 246.....	B. M. 247.....	1 4050	+ 0 8770	+ 0 0024	+ 0 8887	- 12 70	229 6043	C. R. $\odot$ M. 247	103 1461	30 7050	Brass-headed nail in root west side of balun of Gilead tree close to fence on east side of post road, opposite Alphime Dupre's land.
B. M. 247.....	B. M. CXXXI.	1 2047	+ 7 3638	+ 7 3691	+ 7 3665	- 2 60	11 2227	C. R. $\odot$ M. CXXXI	104 3013	47 0715	Copper plug in wall above verandah floor, south side of front door of Pierre Chicoine's stone house on north-east side of post road.
B. M. CXXXI B. M. 248.....		1 2497	+ 14 8659	+ 14 8570	+ 14 8614	+ 4 40	30 9831	C. R. $\odot$ M. 248	105 6010	61 0329	Brass-headed nail in root of poplar tree, west side of post road, near Louis Dion's house.
B. M. 248.....	B. M. CXXXII.	0 9235	+ 8 1892	+ 8 1872	+ 8 1892	+ 1 00	2 1657	C. R. $\odot$ M. CXXXII	106 5245	70 1211	Copper plug on base of pillar, north-west side of main entrance door to Vercheres R. C. parish church, on east side of post road.
B. M. 248.....	B. M. CXXXIII.	0 9230	+ 8 3456	+ 8 3435	+ 8 3446	+ 1 10	2 5547	C. R. $\odot$ M. CXXXIII	107 4475	70 2775	Copper plug in stone plinth on south-east side of Priest's house, 7 ft. from S. E. corner, on east side of post road.
B. M. CXXXII B. M. 249.....		1 2402	+ 1 9030	+ 1 9231	+ 1 9131	- 10 00	161 2643	C. R. $\odot$ M. 249	107 7647	72 0342	Brass-headed nail in root of large ash tree, near road fence, in Alfred Pigeon's field, east side of post road.
B. M. 249.....	B. M. 250.....	1 0438	- 7 2327	- 7 2175	- 7 2251	- 7 60	110 6725	C. R. $\odot$ M. 249	108 8085	64 8091	Brass-headed nail in root of elm tree, near eastern road fence, opposite Norbert Geoffrion's property.
B. M. 250.....	B. M. CXXXIV.	0 8846	+ 9 2018	+ 9 1912	+ 9 1965	+ 5 30	63 5089	C. R. $\odot$ M. CXXXIV	109 6931	74 0056	Copper plug in stone, north-east gable of Urqule Cadieux's house, on north-west side of post road.
Carried forward.....		28 2671	+ 27 6267	+ 27 6763	+ 27 6515	- 24 80	3079 6251				

Carried forward .....

IX. ALLEGHETIC LEVELLING RIVER ST. LAWRENCE. Continued.  
 A section of Route, Section No. 2, Sord to Varennes (Continuous line) Continued.

Distance or Height				V	2 V <sup>2</sup>	B. M. W. N. M. E.	Miles	Feet.	Locality, &c.
				Data from Mean.	M.				
From	To	Feet.	Feet.	Feet.	1000				
E. M. 200	1. M. 200	21 0205	21 0768	24 80	3070 0205	C.	170 0002	60 4000	Parish of St. Francis-Xavier de Verchères. Concluded.
		4 6430	4 6442	2 40	0 0555	B. M. 2514			
E. M. 200	1. M. 200	16 4742	16 4770	1 80	8 6787	C.	172 0000	62 0000	Bross headed nail in root of large elm tree on Kustache Blau- notte's property, west side of jeat road. Bross headed nail in root of large elm tree, close to road fence on Pabien Lacombe's property, west side of jeat road.
		6 0680	6 0642	26 40	3072 0608	B. M. 2511			
Total		31 2000	31 2000						

Section No. 0 - 31 0000 miles.

Mean error per mile M = 0 00712 feet. Probable error per mile M = 0 0745 M 0 00400 feet.  
 Mean error for whole distance μ = 0 00000 feet. Probable error for whole distance μ = 0 0745 μ 0 02050 feet.

From	To	DIFFERENCE OF HEIGHT.				V. Differ- ence from Mean.	$\frac{2V^2}{M.}$	B. M. W. S. ST. &c.	Distance from Graving Dock and Lévis of level.	Miles.	Feet.	Locality, &c.
		M. Distance.	Line A. ← Line B. →		Mean.							
			Feet.	Feet.	Feet.	Feet.	1000					
B. M. $\diamond$	B. M. 251.....	0·8776	—49·2583	—49·2505	—49·2544	— 3 90	34 6637	C. $\diamond$ B. $\diamond$ M.	206·6313	136 2105		Parish of Sault St. Louis. B. M. $\diamond$ —Chisel mark on cop- ing, about 4 inches below top, near inner corner, S. E. angle southern abutment C. P. R. bridge, Caughnawaga.
B. M. 251	B. M. CXXXV.	0·8580	— 7·4752	— 7·4686	— 7·4719	— 3 30	25 3846	C. $\bullet$ M. R. $\bullet$ M. 251 C. $\bullet$ M. CXXXV	206·7537	86 9661		B. M. 251—Brass-headed nail in root west side of elm tree in Lazaire Dailbont's field, about 150 feet south of road fence.
B. M. 251	B. M. 252.....	0·9115	—12·4000	—12·3894	—12·3967	— 3 30	23 8947	C. $\bullet$ M. B. $\bullet$ M. 252	206·6117	79 4842		B. M. CXXXV—Copper plug in third course from ground, south- west face of abutment new of C. P. R. bridge, Caughnawaga side of St. Lawrence.
B. M. 252	B. M. 253.....	1·1767	+ 4·2248	+ 4·2094	+ 4·2171	+ 7 70	100 7734	C. $\bullet$ M. B. $\bullet$ M. 253	204·8422	74 5594		B. M. 252—Brass-headed nail in root of small balm of Gilead tree, west side of post road on Ignace Chicot's property.
Carried forward .....		2·9658	—57·4335	—57·4345	—57·4340	+ 0 50	159 3308		203·6655	78 7765		B. M. 253—Brass-headed nail driven horizontally into tele- graph pole on Joseph Rinfret's property, east side of post road.



R.M. 264. CXXXVII.	R.M. 257. CXXXVIII.	0 16423	+ 6 3124	+ 6 3245	+ 6 3104	7 10	104 8400	R. $\odot$ M. CXXXVII	1196 3070	05 9121	R. M. CXXXVII—Copper plug in north gable of Moine-Brault's story and a-half brick house at junction of roads to St. Pierre and Caughnawaga.
R.M. 258. CXXXVIII.	R.M. 257. CXXXVIII.	0 6417	-- 3 2151	-- 3 2187	-- 3 2180	+ 1 80	10 0682	B. $\odot$ M. 257.	198 0009	62 0862	B. M. 257—Brass-headed nail on root, east side of large ash tree, near line fence between Pierre and Alphonse Bronseau.
R.M. 258. CXXXVIII.	R.M. 257. CXXXVIII.	0 9292	-- 1 5773	-- 1 5647	-- 1 5710	-- 6 30	85 4283	R. $\odot$ M. CXXXVIII	196 7367	61 1242	B. B. CXXXVIII—Copper plug in stone quooin, north-west corner of S. Pagnolo's cut stone house on east side of Post Road.
R.M. 258. CXXXIX.	R.M. 257. CXXXIX.	1 2260	+ 1 4904	+ 1 4641	+ 1 4772	+ 13 10	279 4511	B. $\odot$ M. CXXXIX	196 5107	62 6014	B. M. CXXXIX—Copper plug in stone plinth 1 35 ft. above entrance step at north-west corner of Roman Catholic parish church, village of Laprairie.
R.M. 258. CXXXIX.	R.M. 258. CXXXIX.	0 3060	-- 14 8615	-- 14 8524	-- 14 8570	-- 4 00	107 1392	B. $\odot$ M. 258.	196 1157	47 7444	B. M. 258—Brass-headed nail in root north-west side of a group of large balm of Gilead trees on east side of Post Road, some 350 ft. below wharf.
R.M. 259. CXL.	R.M. 259. CXL.	1 4032	+ 2 8482	+ 2 8446	+ 2 8404	+ 1 80	4 6180	B. $\odot$ M. 259.	194 7125	50 5908	B. M. 259—Brass-headed nail in root of large elm stump in gully, about 250 ft. east of road, on Alexis Moquin's field.
R.M. 259. CXL.	R.M. 259. CXL.	1 3823	+ 11 8592	+ 11 8741	+ 11 8607	-- 7 40	79 2303	B. $\odot$ M. CXL	193 3302	62 4575	E. M. CXL—Copper plug in 3rd course above foundation, 3-2 ft. from north-west corner of X. Perrat's story and a-half brick house on east side of Post Road.
R.M. 260. CXL.	R.M. 260. CXL.	0 9709	-- 12 4116	-- 12 4323	-- 12 4220	+ 10 30	218 4585	B. $\odot$ M. 260.	192 3593	50 0355	B. M. 260—Brass-headed nail in root of large elm tree east side of Post Road, close to fence, on Moine Genest's property.
Carried forward .....		14 2720	-- 96 1515	-- 96 1983	-- 96 1756	+ 23 30	1684 9168				




B.M. CXXIII	B.M. 264.	1 0646	0 3604	0 2400	0 2404	40	3046	C. B. 264	185 6906	47 5701	R.M. 264—Brass-headed nail in root of large elm tree on east side of post road, opposite the property of Toussaint Obertin.
B.M. 264.	B.M. 265.	1 0658	- 1 7803	- 1 7032	- 1 7668	- 13 60	350 3604	C. B. 265	185 6897	45 9093	B.M. 265—Brass-headed nail in root of large elm tree, east side of post road, opposite the property of Arsène Charron.
B.M. 265.	B.M. 266.	1 0667	- 1 9762	- 1 9716	- 1 9730	- 2 30	4 2186	C. B. 266	183 5730	43 9354	B.M. 266—Brass-headed nail in root of elm tree, east side of post road, about 20 feet north of fence line between Alex. Dubuc and Geo. Charron.
B.M. 266.	B.M. CXLII.	1 1721	+ 2 4634	+ 2 4551	+ 2 4603	+ 5 20	46 1394	C. B. CXLII	182 4009	46 2957	<i>Parish of St. Famille de Boucherville.</i> B.M. CXLII—Copper plug in third row of bricks above stone work, 4 feet from N.W. corner of Antoine Vinet's story and a-half brick house.
B.M. CXLII	B.M. 267.	0 8485	- 2 8763	- 2 8706	- 2 8735	- 2 90	19 8221	C. B. 267	181 5524	43 4222	B.M. 267—Brass-headed nail in root west side of elm tree, in fence line between Jos. Duracher and Toussaint Sicotte, east side of road.
B.M. 267.	B.M. CXLIII.	0 8690	+ 11 7255	+ 11 7124	+ 11 7190	+ 6 60	100 2532	C. B. CXLIII	180 6834	55 1412	B.M. CXLIII—Copper plug in second quoin above steps at S.W. corner of Roman Catholic parish church, east side of post road, village of Boucherville.
B.M. CXLIII	B.M. CXLIV	1 4426	- 6 5552	- 6 5942	- 6 5447	- 10 50	152 9506	C. B. CXLIV	179 2400	48 2962	B.M. CXLIV—Copper plug in stone of foundation under centre of window sill, near S.E. corner of story and a-half brick house belonging to François Birtz.
B.M. CXLIV.	B.M. 268.	1 3501	- 9 9686	- 9 9707	- 9 9697	+ 1 00	1 4824	C. B. 268	177 8908	38 6268	B.M. 268—Brass-headed nail in root on south side of large balm of Gilead tree, about 130 ft. west of farm road in Chas. Dubois' field, north-west side of post road.
Carried forward.....		28 7405	- 97 5657	- 97 6015	- 97 5837	+ 17 80	27 97 7128				



N.A. GEODETIC LEVELLING - RIVER ST. LAWRENCE (Continued).  
 Abstract of Results, Section No. 84, Chambly Basin to Longueuil (Continuous line) (Continued).

[1891]

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From	To	M. Distance.	DIFFERENCE OF HEIGHT.			V. Differ- ence from Mean.	$\frac{2V^2}{M}$	B. M. W. S. ST. &c.	Distance from Levis Graving Dock to level.	Miles.	Feet.	Locality, &c.
			Line A.		Line B.	Mean.						
		Miles.	Feet.	Feet.	Feet.	Feet.						
B.M. 63. ....	B.M. 223. ....	0.9254	+16.1321	+16.1420	+16.1371	- 4.9	51.8911	C. M. B. 63	198.8354	40.7045		Parish of St. Joseph de Chambly. Brass-headed nail on top of large elm stump, near water's edge, north side of Little Montreal River, and about 60 feet west of post road bridge over this river.
								C. M. B. 223	197.9100	56.8416		Brass-headed nail on root of large elm, south side of post road, in Debardeau's field, lot No. 110.
B.M. 223. ....	B.M. CXVIII	0.9624	+29.6467	+29.6332	+29.6399	+ 6.7	93.2876	C. M. B. CXVIII	196.9476	86.4815		Parish of St. Hubert. Copper plug in south-east gable end of Wilfred Daignault's stone house, on north side of post road, lot No. 84.
B.M. CXVIII	B.M. 224. ....	1.3204	+6.1312	+6.1014	+6.1163	+14.9	336.2768	C. M. B. 224	195.6272	92.3978		Brass-headed nail on root of large elm tree, south side of post road, on Alfred Brassard's property, lot No. 98.
B.M. 224. ....	B.M. 225. ....	0.8085	- 7.4040	- 7.3886	- 7.4013	- 2.7	16.2270	C. M. B. 225	194.7287	85.1965		Brass-headed nail on root of large elm tree, on south side of post road, in Benjamin Brassard's field, lot No. 107.
Carried forward. ....		4.1067	+44.5060	+44.4780	+44.4920	+14.0	497.6825					

**XX AGRICULTURAL LEVELLING—RIVER ST. LAWRENCE. Concluded.**  
*Continued from No. 1, Champlain Basin to Longueuil (Continuous line) Concluded.*

From		To		Distance of Station		Intermediate of Station		V. Difference		2 V/2		B. M. W. N. &c.		Distance from 1st to 2nd		Feet.		Locality, &c.
Station	Point	Station	Point	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	
1	1000	2	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	Parish of St. Hubert—Concluded.
1	1000	2	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	Copper plug in stone foundation, west side of J. B. E. Charron's house, south side of post road, lot No. 116.
1	1000	2	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	Copper plug in cut stone foundation of Antoine Rocheleau's stone house, on north side of post road, lot No. 38.
1	1000	2	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	Brass-headed nail on root of large elm tree alongside of post road fence, at Provost's blacksmith shop door, lot No. 32.
1	1000	2	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	Parish of St. Antoine de Longueuil.
1	1000	2	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	Copper plug in east gable end of Hillaire Lamarré's stone house, south side of post road, on lot No. 116.
1	1000	2	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	4	1000	Brass-headed nail in root of large elm tree, in François Millet's field, lot No. 98.

B.M. 227	B.M. CXXII	0 8031	+ 0 1043	+ 0 1280	+ 0 1419	+ 12.4	420.9048	B. $\odot$ M. CXXII	186.8883	100.9497	Copper plug in north-east gable end of Pierre Benoit's stone house, south side of post road, at south-east end of lot No. 132.
B.M. CXXI	B.M. 228	1.1369	-18.7340	-18.7107	-18.7224	-11.7	240.8128	B. $\odot$ M. 228	187.7284	82.2673	Brass-headed nail on root of large elm tree, south side of post road, in Damase Brissette's field.
B.M. 228	B.M. CXXIII	0.9684	-25.4404	-25.4613	-25.4508	+10.5	227.6852	B. $\odot$ M. CXXIII	186.7600	56.8165	Copper plug in cut stone basement wall near door in eastern side of Longueuil new R. C. church, on south-west side of road to Chambly.
Grand Totals		12.0754	+16.1383	+16.0847	+16.1120	+27.3	1963.0247				

Section No. 8½ = 12.0754 miles.

Mean error per mile ..... =  $M = 0.00505$  ft. Probable error per mile ..... =  $\dot{M} = 0.6745$   $M = 0.00511$  ft.

Mean error for whole distance ..... =  $\mu = 0.03143$  ft. Probable error for whole distance ..... =  $\dot{\mu} = 0.6745$   $\mu = 0.02121$  ft.

## X A. GEODETIC LEVELLING RIVER ST. LAWRENCE Continued.

Crossing of levels from Longueuil to Montreal via St. Helen's Island.

Abstract of Results, Section No. 10½, east end of Montreal Harbour to Lachine C. P. R. Bridge (Continuous line).

		DIFFERENCE OF HEIGHT.				V		B. M. W. M. &c.		Elevation above or below level Atlantic Ocean by R. Sackell-Longueuil		Locality, &c.	
From	To	Miles.	Less A.		Plus B.		Differ- ence from Mean.	2 V <sup>2</sup> M	C. M. B. M. W. M. &c.	Distance from Longueuil to Lachine	Feet.	Feet.	
			Feet.	Feet.	Feet.	Feet.							
B. M. 203.	B. M. K.	1 4011	+ 30 0216	+ 30 0100	+ 30 0207			0 0116	C. M. B. M. 203	100 0001	44 0400		Parish of St. Antoine de Longueuil. B. M. 203 Brass headed nail on root west side of large elm tree, north-west side of post road, opposite the property of Messrs. Marcoux, Barsalon & Co.
B. M. K.	B. M. M.	1 0100	36 5525	36 5475	36 5501		2 0	0 0008	C. M. B. M. K.	100 4722	83 0007		City of Montreal. B. M. K. Copper plug in solid rock, near closed in grout hole, lower end and south side of St. Helen's Island, west side of road around island.
	Totals	2 0251	+ 2 4000	+ 2 4794	+ 2 4706		1 0	0 2024	C. M. B. M. M.	101 0022	47 4100		B. M. M. Copper plug in third stone course above ground on east face southern abutment of C. P. R. bridge over Brock street, along Montreal Harbour front.

Crossing from Longueuil to Montreal.

2 0251 miles.

Mean error per mile.	0 00152 feet.	Probable error per mile.	0 00745 M	0 00103 feet.
Mean error for whole distance.	0 00210 feet.	Probable error for whole distance.	0 00745 M	0 00103 feet.

# DIFFERENCE OF HEIGHT.

From To

Miles. Feet. Feet. Feet.

1000

City of Montreal.

Distance from Level (Gravimetric) Miles. Elevation, above + below approximate mean level, Atlantic Ocean by R. Breckel, 1880-82.

B. M. W. S. ST. & C.

2 V<sup>2</sup> M.

Feet.

Miles.

Locality, &c.

B. M. L.

192 1662

43 8614

B. M. L.—Copper plug in stone course above ground, east corner of southern abutment of C. P. R. bridge on Forsyth street, leading to Longueuil ferry.

B. M. M.

191 0922

47 4196

B. M. M.—Copper plug in third stone course above ground on east face of southern abutment of C. P. R. bridge over Brock street, along Montreal Harbour.

B. M. N.

191 0907

55 1614

B. M. N.—Copper plug in southern wall of Custom House, near north-west corner of Commissioners' and Port streets.

B. M. O.

192 2380

55 0928

B. M. O.—Copper plug on first quoin above front plinth course, near S. E. angle of Examining Warehouse on Commissioners street, a few feet north of its intersection with McGill street.

B. M. P.

193 6788

44 2963

B. M. P.—Copper plug on northern or lower side of north shore abutment of Victoria Bridge. Bench is down on beach in third course of stone above ground.

Carried forward



<i>Parish of Lachine.</i>									
B.M. a.	B.M. p	0 5434	8 7300	8 7400	8 7307	+ 7 0	220 7010	B. $\odot$ M. $\mu$	54 5010
									100 1050
B.M. p.	B.M. q.	0 8478	+ 5 9784	+ 5 9737	+ 5 9791	- 6	8493	B. $\odot$ M. $\eta$	60 4801
									100 1028
B.M. q.	B.M. r.	0 6847	+ 12 2886	+ 12 2841	+ 12 2864	+ 2 3	15 8832	B. $\odot$ M. $\tau$	72 7655
									200 6165
B.M. r.	B.M. s.	0 8838	+ 6 0372	+ 6 0414	+ 6 0313	-- 2 1	9 9571	B. $\odot$ M. $\rho$	78 8058
									201 5053
B.M. s.	B.M. t.	0 8110	+ 8 0348	+ 8 0749	+ 8 0674	+ 7 5	138 7176	B. $\odot$ M. $\kappa$	70 7384
									202 3103
B.M. t.	B.M. u.	1 1065	+ 2 9761	+ 2 9848	+ 2 9805	-- 4 3	33 4207	B. $\odot$ M. $\epsilon$	73 7189
									203 4228
B.M. u.	B.M. v.	0 6918	+ 26 3861	+ 26 3830	+ 26 3845	+ 1 5	49 0196	B. $\odot$ M. $\nu$	100 1134
									203 5146
Totals.....		13 4904	+ 56 3045	+ 56 1992	+ 56 2620	+ 59 2	1656 2815		

Section No. 104 = 13 4964 miles.

Mean error per mile ..... = M = 0 00743 foot. Probable error per mile ..... = M = 0 6745 M = 0 00601 foot.

Mean error for whole distance ..... =  $\mu$  = 0 02729 foot. Probable error for whole distance. .... =  $\mu$  = 0 6745  $\mu$  = 0 01841 foot.

B.M. p. Brass-headed nail in south side of elm tree, on south side of Lachine lower road, opposite centre of lot No. 989, owned by Frederick Mathews.

B.M. q. Brass-headed nail in root of elm tree, west side of Lachine River road, nearly opposite centre of lot No. 986, part of the estate of the late H. Fraser, Esq.

B.M. r. Brass-headed nail on root, west side of elm, on west side of Lachine lower road, opposite east end of lot No. 983, owned by D. McDonald.

B.M. s. Copper plug in 5th course of cut stone above springing of arches of bridge over old Montreal water works canal, north face of west pier.

B.M. s. Brass-headed nail on root, east side of balin of (il)-lead tree on beach, nearly opposite lower line of lot No. 973, owned by Daniel Fraser.

B.M. t. Brass-headed nail on root of balin of (il)-lead tree on beach, near lower side of Lachine C.P.R. bridge.

B.M. v. Copper plug in second stone course from ground, S.W. or upper face of stone abutment of C.P.R. bridge, south side of Lachine lower or river road. Not numbered yet.



## TIDAL PHENOMENA.

The tides are all, as is well known, secondary effects of the force by which the sun, earth and moon are believed to attract each other, viz., the force of gravitation.

Although containing 27,000,000 times less matter than the sun, the moon, on account of being nearly 400 times nearer to the earth, produces tidal undulations about two and a-half times greater than those which the sun gives rise to. Owing to the largely preponderating influence of the moon, the tidal undulations follow this body in her motions about the earth, generally with comparatively slight variations.

It is often explained that the tidal intumescence is one of the immediate or direct effects of the variation of the intensity of gravitation, which force makes itself felt in the inverse ratio of the square of the distance between the centre of gravity of any quantity of matter subjected to it and that of the attracting body; the consequence being that every wave has to move, so that its summit or crest may always be approximately in the meridian plane, which passes through the last named body, when either above or below the horizon. It is claimed at the same time that this summit would be found to coincide with the meridian plane just mentioned out in the ocean, were it not for the interference with the regular propagation of the wave by such disturbing elements as: abrupt changes in the depths of the sea, islands, jagged coast lines of continents, etc., etc.

This may be termed the statical conception of the tidal phenomenon, according to which the water is supposed to take at every instant, the position of equilibriums, which suits the momentary intensity and direction of the forces at work.

That the diminution or increase of weight which obtains in all matter subjected to the attracting influence of heavenly bodies, is not sufficient to account satisfactorily for the formation of tidal waves, is demonstrated by the ascertained fact that the action of the moon at the surface of the earth is but one twelve-millionth ( $\frac{1}{12,000,000}$ ) part of that of gravity at the same place, while that of the sun is less than  $\frac{1}{25,000,000}$ , or less than half that of the moon.

Instead of being a vertical displacement of liquid molecules or piling up of the same of a hydrostatic nature, directly induced by the varying attraction of the heavenly bodies, the primary cause of the formation of all tide waves has recently been proved to be the conversion into hydraulic head, of the living force of opposing horizontal currents of about equal strength, to which slight changes in the direction of the vertical brought about by the attracting bodies give rise. Moreover, the wave motion is not simply periodical, but of the pendular kind; the oscillation body moving always past its position of stable equilibrium and in a direction opposed to that of the force acting upon it, by virtue of the acquired velocity.

According to this, the dynamical conception of the phenomenon, the momentary state of equilibrium corresponding to high water is realized in the natural order of things, when the tide is low and *vice versa*, which theory affords a rational and satisfactory explanation of the long interval that generally elapses between the passage of the moon over the meridian and the occurrence of the next succeeding high water, even at the most exposed points along or off the sea coasts of both the old and the new continent.

The tides of the north Atlantic are believed to be contemporaneous on the European and American coasts, that is to say, that the tides that are felt about the same absolute time on the western coast of Europe and the eastern coast of North America, apparently correspond to the same transit of the moon over the meridian passing through a point in the oceanic region where all Atlantic tides may be considered to originate, and which may be termed their common focus. On both coasts each wave is believed to be at least 36 hours, or  $1\frac{1}{2}$  lunar days, behind the passage of the moon which gives

rise to it, over the focus meridian; judging by the data afforded by long series of observations made on both sides of the Atlantic.

It is found that when:

$V$  represents the mean rate of propagation or velocity of a tide wave,

$L$  its length,

$H$  the mean depth of the water in which it moves,

$T$  the time occupied by it in travelling over a distance equal to its length, or the duration of its oscillation,

$a$  the semi-amplitude,

$c$  the mean velocity of the stream of flood,

$l$  the length of the zone of flood, equal for long waves to  $\frac{L}{2}$ ,

$\lambda$  the length of the excursion or path followed by a particle of water in the stream,

$g$  the acceleration of gravity = 32.16 ft. per second, the whole as exemplified in diagram A.

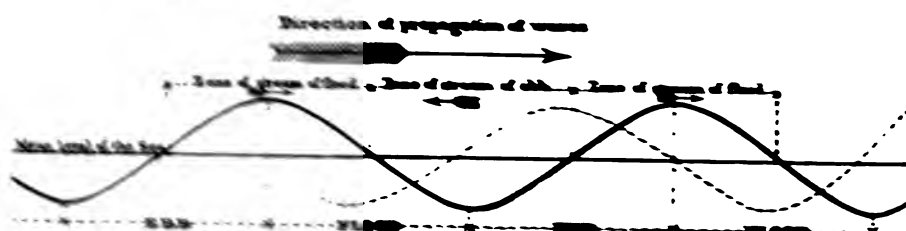


Diagram - A

The wave is long, and the velocity of propagation is small, and the wave is long, and the wave is long.

$$V = \frac{L}{T} = \frac{L}{\frac{2\pi}{gH}} = \frac{L}{2\pi} \cdot \frac{gH}{L} = \frac{gH}{2\pi}$$

$$T = \frac{L}{V} = \frac{L}{\frac{gH}{2\pi}} = \frac{2\pi L}{gH}$$

$$L = \frac{V}{\frac{gH}{2\pi}} = \frac{V}{\frac{gH}{2\pi}} = \frac{V}{\frac{gH}{2\pi}}$$

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Now, if we take  $L = 100$  miles,  $H = 100$  feet, and  $g = 32.16$  ft. per second, we find

$T = \frac{2\pi L}{gH} = \frac{2\pi \times 100 \times 5280}{32.16 \times 100} = 200$  seconds, or 3 minutes and 20 seconds.

Now, if we take  $L = 100$  miles,  $H = 100$  feet, and  $g = 32.16$  ft. per second, we find

$V = \frac{gH}{2\pi} = \frac{32.16 \times 100}{2\pi} = 511$  ft. per second, or 34.7 miles per hour.

trinity of Newfoundland and in longitude  $53^\circ$  west, at VII h. on full and change days; and in Amherst Harbour, in longitude  $62^\circ$  on Amherst Island, the most southern one of the Magdalen group, high water was observed to occur at VIII h. 20m. full and change.

If the Atlantic tidal oscillation was propagated in a direction parallel to the southern coast of Newfoundland, by allowing 36 minutes time for the difference of longitude between Cape Race and Amherst Harbour, we would have along this stretch of about 360 nautical miles:  $V = \frac{360 \text{ m.} \times 6076.5 \text{ ft.}}{6960 \text{ sec.}} = 315 \text{ ft. per second}$ , whence the

average depth  $H$  of the sea in which the wave moves, as given by the formula:  $H = \frac{V^2}{g}$  should be 3,090 feet, which is three to four times greater than the actual depth ascertained by sounding.

The cotidal lines seem to indicate that the tide wave proceeds through Cabot Strait in a more northerly direction, than that indicated by the general outline of the southern coast of Newfoundland from Cape Race to Cape Ray.

Taking 200 fathoms to be the mean depth  $H$  in the approach to the southern entrance to the Gulf of St. Lawrence from a point opposite Cape Ray to the Magdalens, the more probable rate of propagation is found to be approximately:

$$V = \sqrt{32.16 \times 1,200} = 196.4 \text{ feet.}$$

Moreover, the general relations given above afford in such case the following results, viz.: Semi-amplitude  $h = 1.905 \text{ ft.}$ , whence the total rise and fall  $= 2h = 3.81 \text{ ft.}$ , which does not differ materially from some of the amplitudes actually observed: also

$L = 8,799,000 \text{ ft.}$  and  $r = 0.31 \text{ ft.}$  Again, by making  $\lambda = \frac{L}{2} = 4,399,500 \text{ feet}$ , we obtain:  $l = 14.013 \text{ feet.}$

With an average velocity of 196.4 ft. instead of 315 ft., the distance over which the wave travels from a point opposite Cape Ray, say in longitude  $56^\circ$  west, where it is high water at full and change at VII h., up to a point opposite the Magdalens in longitude  $61^\circ 30'$  where the corresponding time of high water is VIII h. 20m., is found to be 6,120 sec.  $\times 196.4 \text{ ft.} = 1,201,968 \text{ ft.} = 198 \text{ nautical miles}$  instead of 360.

On account of Cabot Strait being from six to seven times as wide and from six to seven times as deep as the Straits of Belle-Isle, affording, therefore, a passage say forty-five times as large, the tidal fluctuations of the St. Lawrence estuary are chiefly governed by the water admitted from the sea through this, the southern inlet; the undulation which finds its way through the northern inlet, manifesting itself rather as a disturbing element of the regular propagation of the principal wave than otherwise.

After passing into the Gulf between Cape Breton Island and the south-western end of Newfoundland, the incoming southern wave may be divided into four sections, following different directions at varying rates of speed. The first or principal section continues to advance in a north-westerly direction towards the Baie des Chaleurs, the mouth of the St. Lawrence estuary proper, the Island of Anticosti and the northern gulf coast in the vicinity of this island. The second section is deflected to the southward, along the eastern side of the Magdalen group towards the Gulf of Canso and the north-eastern entrance to Northumberland Straits, and the third section to the south-west and westward, along the western side of this group of islands towards the north-western entrance to the same straits; both these sections of the main undulation meeting each other about the centre of the straits. The fourth section makes its way in a northerly direction along the western shore of Newfoundland towards the south-western end of the Straits of Belle-Isle and the northern gulf coast east of the Island of Anticosti, where it meets the comparatively unimportant northern undulation which passes inward through these straits at a much slower pace than the southern wave, on account of the decreased average depth of water, say 25 to 150 fathoms, through which the oscillatory motion is propagated, instead in from 200 to 300 fathoms.

It is principally on account of the sudden closing up, or contraction of the tideway at: Pointe des Monts and possible consequent reflection of a portion of the southern un-



$$V = \frac{6076.5 \times 222}{(6 \text{ h } 54 \text{ m}) = 24,840 \text{ secs.}} = 54.30 \text{ feet,}$$

$$H = \frac{V^2}{g} = 91.7 \text{ feet.}$$

$$L = TV = 44,700 \text{ V} = 2,427,200 \text{ feet,}$$

$$h = \frac{66}{\sqrt{H}} = 6.90 \text{ feet.}$$

$$v = \frac{h \sqrt{g}}{\sqrt{H}} = 4.09 \text{ feet per second,}$$

$$\lambda = \frac{L}{2} = 1,213,600 \text{ feet,}$$

$$l = \frac{\lambda h}{H - h} = 98.748 \text{ feet.}$$

As the amplitude of ordinary springs is stated by the Admiralty authorities to be about 12 feet at Pointe des Monts and 18 feet at the city of Quebec, the mean of which is 15 feet, the value of 6.90 feet just deduced for the semi-amplitude  $h$  is not very far from being concordant with the said mean.

At the end of a complete semi-tide day of an average duration of 12h. 25m., the summit of the wave which passes opposite Cape Ray at VIIIh. full and change, has, according to approximate data from Admiralty charts, reached a point very little below Quebec city, say the new Graving Dock, where it is high water at about VIIh. — 25m. local time on full and change days, and the average wave length  $L$  corresponding to the stretch between Quebec and Pointe des Monts, as just computed, is very nearly the same for the portion of estuary lying between the latter place and the Graving Dock.

If now we give weights to the computed wave lengths corresponding to the three stretches considered between Cape Ray and the Graving Dock, according to the number of seconds occupied by a wave in passing over each space, and divide the sum of the resulting products by the mean length of a semi-tide day = say 44,700 seconds, we find that the whole length of the wave occupying the space between the two extreme points just mentioned should be :

$$\frac{8,799,000 \times 6,120 + 493,950 \times 14,580 + 2,430,000 \times 24,000}{44,700}, \text{ or}$$

$$1,448 \times 6,120 + 812.8 \times 14,580 + 400 \times 24,000 = 679 \text{ nautical miles}$$

as against  $(198 + 265 + 220) = 683$  nautical miles according to direct measurement.

The close agreement of the wave lengths thus determined tends to indicate, that on account of the vast proportions of the lower St. Lawrence, neither a fresh water discharge of from 300,000 to 400,000 cubic feet per second or more, nor the rise of the bed or the contraction of the tideway, materially affect the regular propagation of the oceanic waves in and outward according to the laws which are believed to govern the same in the open sea, even as far inland as Quebec city. We shall see presently, however, upon further investigation, that the tide wave itself suffers some modifications in ascending this vast estuary, the same as in all others.

In calm weather and when the mercury of the barometer stands at about its mean height of say 30 inches, it is found at exposed points along the Atlantic coast, that the mean level of the tide-water lies nearly midway between the average elevations of the two high and the two low water marks of a tide day, as shown in diagram B and, moreover, agrees within narrow limits with that which obtains out in the ocean.



Channel, Bay of Fundy, and at Baie Verte, Gulf of St. Lawrence, in connection with his survey for the projected Baie Verte Canal, (b) at Rimouski, in connection with the soundings taken in view of the projected formation of a harbour of refuge in the vicinity of this town, (c) in 1876, at Quebec, during the survey of the St. Charles estuary, previous to the construction of the new docks; second: by the registers of tidal observations, etc., made under my own supervision, 1880-82, at Quebec and several other places above this city in connection with the hydrographic survey of the St. Lawrence ordered by this Department between Quebec and Cap à la Roche, only a small portion of which has been completed in the vicinity of Pointe aux Trembles (en bas), Ste. Croix, etc.

Diagram No. 1 for Cumberland Basin, Bay of Fundy, is based on 54 flood and ebb-ranges observed out of a total of 262 tides which occurred 17th August to 28th December, 1870, viz., on less than one-eighth the whole number of ranges which obtained during the interval between the said dates. The greatest deviations of the highest and lowest mean tide levels from the average of the 54 observed, were respectively -0.76 ft. and -0.74 ft. Least range recorded at neaps, 26.5 ft.; greatest at springs, 47.60 ft.

Mean ratio  $\frac{IH}{HL}$  of tidal intumescence  $\overline{HL}$  to portion  $IH$  above level  $AB$  supposed to

$\overline{HL}$

coincide with level of tideless bay, gulf or estuary = 0.484.

Mean ratio  $\frac{IL}{LH}$  of tidal intumescence  $\overline{HL}$  to portion  $IL$  below level  $AB$  = 0.516.

$\overline{LH}$

Mean ratio  $\frac{IL}{IH}$  of depth — or of height + of trough  $L$  above supposed level  $AB$  of

$\overline{IH}$

tideless bay, gulf or estuary, to height of summit of wave above this level = 1.066.

In constructing diagram No. 2, I was guided by 94 ranges registered at the mouth of the River Tidnish on Baie Verte, Gulf of St. Lawrence, between 20th August, 1870, and 1st June, 1871, out of a total of 1,132 ranges. Here the greatest deviations of the highest and lowest mean tide levels from the average of the 94 determined were as great as -1.29 ft. and -1.20 ft.; minimum range recorded, 0.54 ft.; maximum range, 7.95 ft.

$\frac{IH}{HL} = 0.4634,$

$\frac{IL}{LH} = 0.5366,$

$\frac{IL}{IH} = 1.159.$

$\overline{HL}$

$\overline{LH}$

$\overline{IH}$

Diagram No. 3 is for Rimouski, where the high and low tide levels of 83 floods and 59 ebbs forming 142 ranges, were registered between 22nd July and 29th November, 1870; being over 25 per cent out of a total of 504 ranges. During the interval mentioned, the water level fluctuated at the foot of the St. Ours Lock, according to the water register regularly kept there, between elevations 20.41 and 23.16 above datum, which correspond to about 20.15 ft. and 22.80 ft. above the 0 of the present Montreal Harbour Commissioners' gauge at Sorel. The vertical displacements of the geometrical loci of the crests and troughs of the tide waves caused by these variations in the fresh water discharge, were, however, too small to permit of distinguishing them from the effects of diurnal line qualities, swells raised by winds, etc. The loci shown may be assumed to correspond approximately to a mean river level 21.3 ft. above the zero of the Sorel gauge.

The greatest deviations of the highest and lowest mean tide levels from the average of the 83 flood and 59 ebb, in all 142 mean tide levels, that were determined are + 3.31 ft. and -2.05 ft.

Maximum range recorded = 15.2 ft.

Minimum range recorded = 3.1 ft.

Mean of the 142 ranges recorded = 9.13 ft.

$\frac{IH}{HL} = 0.5901,$

$\frac{IL}{HL} = 0.410,$

$\frac{IL}{HI} = 0.695.$

$\overline{HL}$

$\overline{HL}$

$\overline{HI}$

Diagrams Nos. 4, 5 and 6 show approximately the positions of the loci at Quebec, for St. James street, Pointe Platon and Grondines, for river levels at Sorel corresponding, on an average, to 20.50 ft., and 26.50 ft. above the 0 of the Sorel gauge, as shown on diagram No. 7, or to elevations 20.55 ft. and 25.55 ft. above datum.

These diagrams are respectively based on 380, 261 and 414 high, and 371, 251 and 416 low water levels observed and registered 27th April to 4th December, 1882, viz. during  $7\frac{1}{2}$  lunar months, out of a total of 444 high and 444 low tide levels, while the river stood at heights varying between 20.0 ft. and 27.5 ft. above the 0 of the Montreal Harbour Commissioners gauge at Sorel, or 20.05 ft. and 27.55 ft. above datum.

On diagram No. 6 have been added: the loci of the high and low water levels observed at Quebec during the winter of 1876, viz. 11th February to 26th April, while the waterway was partially blocked up by ice from the mouth of the River Chaudière—about 7 miles above the Lévis Graving Dock—westwardly.

TABLE I.

CHARACTERISTIC RESULTS OF TIDAL OBSERVATIONS MADE AT QUEBEC DURING THE WINTER OF 1876.

	Fect.
Maximum flood range observed 25th February after persistent westerly storms. . . . .	20.9
Maximum ebb range observed 8th March after persistent easterly storms. . . . .	20.0
Minimum flood range observed 19th March with westerly storm. . . . .	6.9
Minimum ebb range observed 19th March with westerly storm. . . . .	6.6
Mean range of floods during complete lunar month (No. 1) commencing 26th February and ending 27th March, (all tides observed by night as well as by day). . . . .	15.42
Mean range of ebbs during same lunar month (No. 1). . . . .	15.39
Mean range of floods during complete lunar month (No. 2) commencing March 27th and ending April 25th, 1876, (all tides observed day and night). . . . .	15.29
Mean range of ebbs during same lunar month (No. 2). . . . .	15.29

TABLE II.

Results of Tidal Observations made between Québec and Grandines during the Season of Navigation of 1882, viz. 1st May to 4th December.

	Québec.	Pontre Platon.	Grandines.
	Fect.	Fect.	Fect.
Maximum range observed (not simultaneous). . . . .	19.4	14.30	9.37
Minimum range observed. . . . .	9.0	8.16	3.30
Mean range during the complete lunar month, May 19th to June 18, 1882, (all tides observed by night as well as by day). . . . .	13.47	10.85	5.34
Mean range during the complete lunar month, October 13th to Nov. 12th, 1882, (all tides observed by night as well as by day). . . . .	13.05	11.83	7.33
Observations made on 8th of May showing flood tide to have at 20.0 ft. above the 0 of the Commissioners gauge at Sorel. . . . .	18.00	14.00	8.10
Observations made on 10th of May showing ebb tide to have at 20 feet the Sorel datum. . . . .	17.00	9.40	5.20
Average range of floods during the season of navigation, from May 1st to December 4th, 1882, (all tides observed by night as well as by day). . . . .	9.2	0.6	0.8
Average range of ebbs during the season of navigation, from May 1st to December 4th, 1882, (all tides observed by night as well as by day). . . . .	13.75	11.46	6.01
Average range of floods during the season of navigation, from May 1st to December 4th, 1882, (all tides observed by night as well as by day). . . . .	13.83	11.32	6.32

These ranges were observed at Québec, where the waterway is available throughout the season of navigation, and is sufficient to permit of the passage of the largest vessels.

It appears from the above statement that because of the general lowering of the stream by  $(5.9 \times 0.18) = 1.06$  ft. which took place at Quebec between the end of May and the beginning of November, 1882, viz., from an average monthly level corresponding to a river surface 26.55 ft. above datum at Sorel, to one corresponding to a river surface 5.9 ft. lower, and at an elevation of 20.65 ft. opposite this town, the mean monthly tidal range increased from 13.41 ft. to 13.95 ft. This rate of change, however, although not much in error, cannot be strictly correct, for no account was taken here of the small variation arising from the difference, as regards mean theoretical or astronomical importance, between the two monthly series of tide waves which ascended the estuary, respectively, from 19th May to 18th June, and from 13th October to 12th November, 1882.

The accurate series of gaugings made during the high and low water seasons in 1887 and 1888, go to show that for a rise of 8.20 ft. in the monthly water level at Sorel, from about 19.45 ft. to 27.65 ft. above datum, the general mean monthly tidal amplitude at Quebec decreases from 13.60 ft. to 13.30 ft., viz., 0.30 ft. But, for reasons stated in a subsequent chapter of this report, we may consider that the depths on sill of lock No. 5 at the head of the Lachine Canal, where the river is open all the year around, vary with the discharge much about the same in winter as in summer, and as these average depths for lunar months Nos. 1 and 2 (1876), above defined, were respectively 10' 9" and 12' 3", the mean of which is 11' 6", it follows that the average discharge during the said winter months was not much inferior to the mean summer discharge. Hence it would appear that the greater portion of this comparatively large increase of, say,  $15.34 - 13.60 = 1.74$  ft. in the general mean monthly tidal amplitude during the winter season is due to the resistance offered by the ice to the free passage of the fluvial wave to the westward of Quebec harbour, in which part of the estuary a friction head is generated by the tidal streams rubbing against the underside of the ice crust.

During the open season, for an increase of 1.74 ft. in the range or amplitude the low water level sank, on an average, only about  $(1.74 \times 0.09) = 0.1566$  ft., while the high water level rose  $(1.74 \times 0.91) = 1.583$  ft. During the said lunar months Nos. 1 and 2, when the river was covered by an ice crust above Quebec, the average monthly high water level appears to have been approximately 0.7 ft. higher than that which obtains with the same fresh water discharge during the summer season, while the average monthly low water level had fallen 1.0 ft. lower than the corresponding water level in summer. The reason of this probably is that, in general, during the winter season less tide-water is admitted and retained in the estuary above Quebec, while it is covered by an ice crust, than in summer when it is unobstructed by ice.

Diagram No. 6 shows at a glance (see Ill. III.) that when the tidal undulation passes opposite the ancient capital, it partakes already much more of the nature of a wave of translation than of that of a wave of oscillation, considering that on an average, about

age, about  $\frac{10}{11} = \frac{\overline{IH}}{LH}$  of its total amplitude, are above the level which the river would assume if abstracted from tidal influence, or say the level of the tideless river, and only

$\frac{1}{11} = \frac{\overline{IL}}{HL}$  below it. But in how short or how long a stretch of the estuary immediately

below Quebec, or how rapidly the fluvial wave rises so much above the mean level of the tideless stream, I am not, as yet, prepared to say. I may point out, however, that as at Rimouski, which place is about 155 nautical miles below Quebec city,

$\frac{4}{10} = \frac{\overline{IH}}{HL}$  of the tidal intumescence rose above the supposed mean level of the tideless

estuary, as shown on diagram No. 5, it may be inferred that the fluvial wave is nearer to being a regular wave of translation than one of oscillation, for less than one-fifth of the total wave length of 683 nautical miles between Cape Ray and the Lévis Graving Dock above referred to (see page 73). This is probably one of the reasons of the close coincidence

of the computed with the actual wave lengths. Again, it must be remembered that when the depth  $H$  is considerable in comparison to the velocity  $U$  of the stream and the height  $h$  of the undulation, its rate of propagation must be nearly the same whether it be a wave of translation or one of oscillation; the rate of the former being in general equal to  $\sqrt{g(H+h)} \pm U$  and that of the latter to  $\sqrt{gH}$ .

Above Quebec a small portion of the fluvial wave continues to descend below the level of the tideless estuary, as far as Ste. Croix on the south shore or Cap Santé on the north shore, and thence westward up to the point where all trace of tidal influence is lost, (in the vicinity of Contrecoeur or Verchères, or even further up), the whole of the tidal intumescence is formed and propagated entirely above the level of the river, the same as in all ordinary simple waves of translation.

While advancing in this, the shallower, steeper and more contracted and obstructed part of the estuary, the undulations naturally become much shorter and somewhat steeper and the rate of propagation is steadily decreasing, until finally both length and amplitude are reduced to 0 and the velocity to a minimum, at the extreme western limit of the maritime portion of the St. Lawrence above Lake St. Peter. Although the fluvial wave continually decreases in length and steepens, while from a perfect wave of oscillation in the Gulf it is being transformed so as to become a regular wave of translation some thirty miles above Quebec harbour, the said wave has not, according to Admiralty chart No. 2516, apparently lost much, if any, in amplitude or range when it reaches this city.

The port of Quebec appears, therefore, to possess all the natural advantages generally afforded by tidal harbours, nearly to the fullest extent possible on the St. Lawrence, besides which, it is also free from the very serious periodical troubles which are caused in some localities situated further up stream, by spring floods and other sudden and irregular fresh water fluctuations, and ice jams and shoves. It is not to be denied, nevertheless, that the lower portions of the city are exposed to be flooded for a short time at high water, when very high spring tides are accompanied by violent north-easterly storms. On the 8th of May, 1874, many vessels were much damaged in their winter quarters by ice jams, owing to the sudden departure of the ice bridge caused by the pressure of the freshet waters against the key of the bridge above the River Chaudière and the ramming operations of steamers; but such ice jams, &c., are of comparatively rare occurrence. (See Appendices Nos. 16, 17 and 18.)

In short inlets and most estuaries of moderate length, not only has one undulation time to make a complete evolution before the succeeding wave commences to enter; but a large proportion of the water admitted also finds its way back to the ocean merely by virtue of the slope assumed by the outgoing stream, so that the elevation or swelling of the same caused, on an average, by the influx of sea water is necessarily always smaller, than that which corresponds to the introduction of a complete tidal undulation from trough to trough, from summit to summit, or between any two other corresponding points of two consecutive undulations. On account of the very great length of the maritime portion of the St. Lawrence, over 800 nautical miles from Cape Ray to Contrecoeur or Verchères, at least two undulations make their way simultaneously up the estuary; the water brought into it by one wave cannot, therefore, flow out again without being incorporated, wholly or in part, in the next succeeding wave, viz., in a manner to satisfy the conditions of the established oscillatory motion. It follows, that in this vast estuary, the mean increases in the area and depth of the waterway and the elevation of the water contained therein which are produced by the influx of sea water, can at no time be less than the corresponding increases which the wave of least importance and amplitude generated in the Atlantic would bring about, viz., the wave which has a coefficient of semi-amplitude equal to about 0.30.

As the waves gain in importance passing from neaps to springs, the volume of water lodging in the estuary increases also, until the maximum elevation corresponding to full or change of the moon is reached, when, all other things remaining equal, the water again descends towards the mean minimum elevation just referred to until it

attains the level corresponding to the lowest succeeding neaps, to rise again with the gaining tides.

The greatest volume of water which can at any time lodge in the estuary under normal conditions of the atmosphere, in addition to that which would be contained therein, if the stream was abstracted from the influence of the tides, is that which can be brought in by the wave corresponding to the maximum theoretical coefficient of semi-amplitude of 118.

According to the Admiralty Charts, it is high water on full and change days, opposite Cape Ray, in longitude  $56^{\circ}$  west of Greenwich, at VIIh., which corresponds to 5h. 44m. nearly, eastern standard time, and at Quebec, in longitude  $71^{\circ} 12'$  west, at VIh. 38m. local time, which corresponds to 6h. 23m. when referred to the meridian in longitude  $75^{\circ}$  west; but it must be observed that the tide wave the crest of which passes Cape Ray at 5h. 44m. is not the same as that which reaches Quebec at 6.23 eastern standard time. This latter wave is one-half lunar day or 12 hours older than the former, that is to say the wave observed at Quebec here referred to, corresponds to a pendular oscillation generated by the moon and sun one-half day ahead of that which is looked upon as having produced the wave observed at Cape Ray now under consideration, viz.: two lunar days = 48 hours, instead of only one and a-half lunar days = 36 hours previous, to the moon's meridian transit immediately preceding the time of high water at Quebec.

In comparing the coefficients of semi-amplitude as deduced directly from the tidal observations made in 1887-88 with the theoretical coefficient given in "*L'Annuaire des Marées*," the difference of age between the tides of the western coast of France and those which make themselves felt simultaneously at and above Quebec city have been duly taken into account.

#### GAUGING OPERATIONS OF 1887 AND 1888.

All the tide and river gauging performed previous to 1887-88 on the St. Lawrence, and to which reference has just been made, was effected by means of simple staffs divided into feet and tenths; the figures denoting the feet being painted in red and the tenths represented by stripes painted alternately blue or black and white. These gauges had generally been put up alongside of wharves, but sometimes also anchored in the stream, where they were maintained in a vertical position by means of chain or other guys, made fast at the lower ends to cast iron weights or to stones put down for the purpose.

In no instance were any special precautions taken with a view of securing smooth water around the gauge by placing it in a box or in any other way, nor was it considered necessary to note the height of the barometer in a regular and continuous manner for the purpose of determining to what extent the height of the water might have been directly affected by variations in the pressure of the atmosphere; moreover, the registered times could not always be relied on as being correct, within the requisite limits, to render the observations and measurements available for the determination of simultaneous water levels. Again, being in 1881-82 under the impression that the tides affected the river at Sorel only to an inappreciable extent, instead of sometimes as much as 1 foot and more, as found out by actual close observation in 1884-85, I attached little importance to the establishment of a river gauging station at a point above this town in connection with tidal observations; hence there were no means available for separating the rise and fall of the river level proper from the fluctuations produced by the tidal undulations. Finally, most of the bench marks made in the vicinity of the gauging stations of 1881-82 have been carried away, disturbed or obliterated by the ice, or otherwise removed or destroyed.

Therefore, notwithstanding the fact that the observations made previous to 1887, just referred to, have afforded valuable information respecting the relative tidal fluctuations, local tide curves, etc., at various points of the St. Lawrence estuary, as shown above, the results obtained could not be directly utilized in connection with the precision level-

ling afterwards performed along the southern shore of the river, for the determination of absolute elevations of water levels corresponding to various phases of the fluvial wave and particular stages of the fresh water stream. Hence the necessity of undertaking more systematic and precise tidal observations and fresh water gaugings during the high and low stages of the river.

This work was carried out, as you are aware, during the fiscal year 1887-88; one series of observations being made in the fall of 1887, viz., during October and a part of November, when the river is at its lowest, and the other series in the spring of 1888, when the stream carries a greater volume of water than at any other season, viz., during the last week in April and nearly the whole of the month of May.

There can be no doubt that if properly constructed self-registering gauges could have been used at all the stations, the most satisfactory results possible would have been arrived at in every respect; but as some 16 or 17 stations had to be established, on account of the great cost of such instruments\*, the idea of securing the necessary information in this manner would have had to be dismissed, even if it had proved practicable to place the apparatus simply on a firm support without providing a special house, etc., for it, as has been attempted by the U. S. C. and G. Survey, with what measure of success I have not learned. But I feel warranted in saying, judging by past experience, that neither on the wharves which are available between Quebec and Montreal for making both high and low water observations, nor at any other point on the river shore that might be found suitable for the object in view, could a gauging apparatus, or, in fact, any other kind of well-finished mechanical contrivance or instrument be safely left in position, unprotected and unwatched even for a few days, much less a month, which is the least space of time generally required for a fairly complete series of observations.

Under the circumstances, it became imperative to devise some simple, inexpensive gauging apparatus which would permit of attaining the desired degree of precision, in results dependent on tidal observations and river gaugings, without running too great a risk of losing a whole season's work by the displacement or destruction, accidental or otherwise, of some of the gauges, or on account of some of their essential parts being broken or put out of order, because of some mishap during the handling of the instrument or at any other time, or owing to mistakes being made in reading or registering the heights, etc., by inexperienced persons such as would, in most localities, have to be employed in order to keep down the expense, and for other reasons not less weighty or more easily got over.

#### GAUGING APPARATUS.

With the aid of illustrations Nos. I. and II.,\* which explain themselves, the construction, installation and manipulation of the gauge designed with a view of meeting the various requirements just referred to, etc., will be fully understood from the following description.

It is a wooden tube of square section 6 inches by 6 inches inside, and 8 inches by 8 inches outside, and of the proper length (15 to 35 feet) to reach from a point on the bottom covered at low tide by 5 to 7 feet water or more up to, but no higher than the top of the capping timber of the wharf to the side of which it is to be fixed, viz., by screwing three or four straps of sheet iron  $\frac{1}{2}$  inch thick by  $1\frac{1}{2}$  inches wide, or thereabouts, to the tube and the wharf timbers. This tube is made of four pine boards one inch thick, all in one piece, planed on one side and screwed together and to a bottom piece 6 inches by 6 inches by 2 inches thick; four or five round holes  $\frac{1}{2}$  inch in diameter are generally pierced in the bottom and from eight to sixteen more are put through the sides, according as the tube stands more or less deep in the water and exposed to the action of the waves. The smooth or planed faces of the boards are turned towards the inside, so that, there being

\* The price of the improved self-registering tide-gauge manufactured by M. M. A. Lévé & Co., of 31 and 32 Kirby street, Hatton Garden, London, England, is from £80 to £100, and M. M. Fauth & Co., of Washington, D.C., U.S., ask \$350 for a self-registering apparatus similar to those made by them for the U. S. C. & G. S. The £100 gauge also registers the height of barometer, temperature and force and direction of wind; but not the others.

\* Full size lithographs of Nos. I. and II. accompany official report for 1890-91.

no horizontal joint in any of them, nothing can interfere with the free motion of the float, which has to move up and down in the tube. If the cutting off of such portion of the box when resting on the bottom, as may stand above the capping timber of the wharf, was neglected, it would surely be wrenched sooner or later out of its primitive position by the hawsers of vessels; in some cases fenders at least 9 inches thick had to be bolted, one on each side of the tube to protect it. The thickness of the sides of the tube was limited to one inch, to facilitate handling in putting it up and taking it down, for it must be remembered that after the low water observations are completed in the fall, all the float tubes have unavoidably to be taken down, not only to keep them from being crushed by the ice during the winter; but also to render them available for use at highest water, early in the spring, before blocks of ice several feet thick, in which they would be embedded if left standing, could be removed without incurring considerable expense and great risk of breaking up the tubes so as to render them unfit for further use.

The gauging apparatus proper consists of a square wooden box B, open top and bottom, and having precisely the same cross-section as the float tube T, viz., measuring 6 inches by 6 inches inside and 8 inches by 8 inches outside and 9 inches in height. On one side are mounted on a horizontal hollow axle *a* made of  $\frac{3}{8}$  inch brass tubing, plugged at both ends to reduce its weight to a minimum: 1st, a reel R, 5 to 6 inches in diameter, constructed of sheet iron or brass, on which is rolled a copper measuring tape or band  $\frac{1}{2}$  inch wide, weighing at the rate of 62 feet per pound when etched ready for use, and of the requisite length to indicate the extreme rise and fall of the tide or river; 2nd, a light brass pulley wheel P, having a diameter of 7 inches, so that when the tape *t* is passed from the reel over the wheel, and a small friction roller placed in a slit I at the underside of the box, or simply through an oblique slit with upper side rounded off, as shown on vertical section, it may hang down exactly in the centre of the float tube.

The tape *t* is hooked to a float F, having the form of a truncated pyramid with sides inclined to each other at an angle of about  $12^\circ$ . It is constructed of tinned plate, soldered at top and bottom to hoops of round galvanized iron wire as shown, and measures 5.5 inches by 5.5 at base and 6.06 inches by 6.06 at top by 4 inches in height, which is just sufficient to prevent the float from sinking when put in the water by itself, viz., independently of the tape and counterweights.

The pyramidal form has been adopted with a view of providing increased play room near the water surface between the float and the box, in comparison to that left at the base of the float, in order to prevent small chips of wood, pieces of paper, etc., which might find their way into the tube, from being jammed or caught between the wood and the tin, so as to interfere with the free motion of the float, more especially in cases where it might be found to be unsafe to put up the float tube in a perfectly vertical position.

In the centre of the lower base of the frustum of the pyramid is soldered a brass tube 0.066 foot or about  $\frac{1}{4}$  inch in diameter and 1.78 inch in height, the top of which is connected with the upper base by an envelope of tin soldered to the square iron wire hoop around this base and to the upper end of the tube, so as to form a hermetically sealed vessel with a cylindrical opening in the centre; this opening is filled with water up to the 0 point of the tape when the gauge is ready for use, and it affords a passage for rain water and small heavy objects dropped inadvertently into the float tube, which would permanently diminish the buoyancy of the float.

The float F is loaded at its underside by means of a sheet of lead having as nearly as possible the same form and area as the lower base to which it is soldered, so that when the spring clip *c*, with lead stretching weight *w*, weighing in all (without discs) 1 pound and 10 ounces—26 ounces—is attached to the tape and the latter hooked to the arched cross bar *m* provided for the purpose at the upper end of the brass tube, the underside of the spring hook *n* which coincides with the zero point of the copper band may be exactly at the water surface.

Four buttons *b* screwed, one on each of the four sides of the gauge box near its base, serve to prevent it from being shifted laterally when once placed fairly over the

float tube, and two counterweights  $c_1, c_2$ , consisting of brass tubes filled with lead, are inserted in the side of the box opposite the pulley wheel, to prevent the apparatus from being unwittingly canted over towards the other side and in order to facilitate the carriage of the same by hand.

Thirty-five to forty loose circular discs of lead  $d$ , of the weight of one foot of tape and having small holes pierced through them near the circumference, accompany each stretching weight  $W$ , which is scooped out in the centre for part of its length to afford room for slipping the discs over a cylindrical brass rod  $j$  secured to the weight. These discs are required for keeping the zero point of the copper tape constantly in the plane of the water surface, viz.: by adding one disc to the weight for each foot of fall and taking one off the same for each foot of rise of the tide: the number of such discs on the weight  $W$  having always to be equal to the number of feet of tape hanging below the top of the brass index bar  $i$  screwed to the sides of the box, as shown in the illustrations. A scale is engraved on the face of the weight  $W$  on both sides of the brass pin, each division of which is equal to the thickness of a disc, so that the total number of discs in use may be ascertained at any time without counting them one by one. As the area of the float opposite the 0 of the tape is nearly 0.2 square foot and the weight of each disc 0.25 ounce, the vertical displacement of the float caused by paying out or taking up one foot of tape is only about 0.0013 feet, an insignificant quantity as regards the present object.

The size of the weight  $W$  and strength of the copper band  $e$ , or rather its thickness, it is to be admitted that  $j$  such is the least which compare with a plain graduation and proper facility for changing the position of the clip before it has risen quite up to the wheel, were the tide is ebbing or after it has descended about one foot below the centre of the wheel during float tide, without risk of deteriorating the divisions in a short time, are regulated by the following considerations, viz.: 1st. the force necessary to overcome the friction generated between the band and pulley wheel, etc., should be smaller than that which would result of the float being raised or lowered in any position to a greater extent than say 0.001 ft. without attempting to regain its original place; 2nd. the tape must be sufficiently stout to indicate the current levels of the water surface below the top of the index bar, and strong enough to bear repeated winding and unwinding, etc., often by the overhauling observer, for weeks together without easily kinking and breaking. I may state in this connection, that a band of only half the thickness of that described above, and weighing at the rate of 12.5 grs. per pound, instead of 62, was found to be too slight and weak to stand much handling. On the other hand, I believe a weight of somewhat less than 25 pounds say 15 pounds would answer the purpose better, for knots arising too thick to slide on so securely in position along the tape by means of a spring clip of similar kind being lower than that used, and which would be easy to make.

A projecting knob in the side of the box opposite that on which the wheel is mounted is to be made high enough for making correct readings opposite the index bar. This projecting knob, as well as a second of transferring the wheel reel, together with weight  $W$ , and clip from the side to the other in case it should be found necessary of a subsequent tide, to be easily reached. In such event the counterweights  $c_1, c_2$  have also to be moved out of the way and the poles provided for them in the opposite side of the box.

When the paying out is to be suspended, the clip and stretching weight  $W$  are to be raised to the level of the bearing opposite the wheel, as shown on the plan. Next, by passing the tape under a finger nail at the upper end of the float, the flow is then drawn up to the reel, the tape being wound up simultaneously with the wheel, so that it does not unwind by locking it with the reel, etc.

As the wheel appears in various stages of its winding, and is balanced so as to revolve freely, the tide may be noted, and can be easily carried by the gauge knife, etc., to the level of the tide, and brought back when again

wanted. There being absolutely nothing left on the wharf which might be stolen, maliciously broken or put out of order by being played with, besides the bare float tube which should be covered to prevent chips or other light refuse from being thrown into it, there is a fair prospect of a complete series of accurate measurements, etc., being secured, extending, say over one month or more, at a comparatively moderate outlay, provided, of course, the observers will discharge their duties faithfully.

I calculated at first to erect all the float boxes in a truly vertical position, in which event no correction for inclination would have been required, but, on more mature consideration, I became convinced that the danger of having the tubes carried away or displaced by steamers or other vessels, etc., and consequent risk of the whole season's work being spoiled—not to mention the extra expense—were so great, that this course however desirable in other respects, could not be uniformly followed—hence many tedious corrections had to be applied to most of the gauge readings. These corrections were based on accurate measurement, of the inclinations of the tubes to the horizon, made with a clinometer and on the depths of the zero point of the tape below the top of the index bar corresponding to the respective inclinations; these depths were determined with the aid of the vernier pointers attached to the foot of the perfected levelling rod used; a short wooden tube having been held for the purpose in inclined positions in a tub partly filled with water.

The following displacements (elevations) of the 0 point have been determined for declinations from the vertical proceeding by whole degrees from 0° to 10°.

TABLE III.

				Feet.
1°	For float tube, vertical: displacement =	.....		0-000
2°	do	declined, 1°, 0 raised =	.....	0-004
3°	do	do 2°, 0 do	.....	0-007
4°	do	do 3°, 0 do	.....	0-009
5°	do	do 4°, 0 do	.....	0-010
6°	do	do 5°, 0 do	.....	0-011
7°	do	do 6°, 0 do	.....	0-012
8°	do	do 7°, 0 do	.....	0-013
9°	do	do 8°, 0 do	.....	0-014
10°	do	do 9°, 0 do	.....	0-014
11°	do	do 10°, 0 do	.....	0-015

Two continuous corresponding series of tidal observations and river gaugings, covering each a complete lunar month and a few days to spare, were made at 17 points between the Lévis Graving Dock and the village of Laprairie: one during the low stage of the St. Lawrence in October and November, 1887, and the other between the end of April and the beginning of June, 1888, when the river is at its highest.

Box and float gauges, such as that just described, were used for observing the tidal fluctuations at the first seven stations above the harbour of Quebec, where the amplitude of the fluvial wave was considered too great, to permit of the observations being conveniently and correctly made at all times without the aid of such apparatus, whether in a sheltered or an exposed situation. Besides these a box gauge (No. 8) was also put up at the Laprairie wharf which is struck to a greater or less extent on every side by the waves raised by winds.

The tabular statement which here follows gives the relative positions of the tide and river gauging stations, the kind of gauge used at each station with its declination from the vertical, and also particulars respecting numbers of observations made, etc.



## RESULTS OF TIDAL OBSERVATIONS AND RIVER GAUGING OF 1887-88.

Appendix No. 13 to this report contains 16 tables, Nos. I to XVI., of results deduced from tidal observations made in 1887-88, during high and low stages of the River St. Lawrence, at eight of the gauging stations established on the shores of the estuary, together with corresponding theoretical data. These tables of comparative results comprise each two series of gaining tides: Nos. I., III., V. and VII., and two of losing tides: Nos. II., IV., VI. and VIII., with the exception of No. VIII. for Champlain station, where only three complete series of tidal observations were made in the fall of 1887, and Nos. II. and V. for the River Chaudière station, where less than two consecutive series of observations were completed in 1887 and the same in the spring of 1888. The said eight series of observations cover two complete lunar months, viz., Nos. I., II., III. and IV., the month in the low water season of 1887, from 12th October to 10th November, and Nos. V., VI., VII. and VIII., the month in the high water season of 1888 from 4th May to 3rd June.

The contents of most of the columns, if not all, are described at such length in the headings, as to call for no further explanations. It is necessary, however, to make special reference to each one of the three sets of eastern standard civil times of high water which have been computed for Quebec. Moreover, a brief description showing the nature of the theoretical or astronomical tidal coefficients, "centièmes," and the uses to which they can be put may not prove superfluous.

The first of the three series of eastern standard times of high water entered on the graving dock table are from the printed Quebec tide tables, for years 1887 and 1888, which have been issued by Mr. Archibald McCallum, who keeps a depot of chronometers and other nautical instruments, charts, etc., in St. Peter street of the said city. The Quebec time of high water, a.m. or p.m. for any given date, appears to have been arrived at by Mr. McCallum by adding sometimes to the corresponding a.m. or p.m. time of high water at London Bridge, as per tide table contained in the Nautical Almanac, and occasionally, for no apparent reason, to the times of high water at London taken out for a half day anterior to that which corresponds to the Quebec time sought, the difference between the respective establishments of the ports of London and Quebec, or, which is the same thing, the difference between the observed times of high water at equinoctial

syzygies in the said ports, viz.: <sup>H. M.</sup> 2 7 at London, as per McGregor's Seaman's Almanac, and <sup>H. M.</sup> 6 38 at Quebec, as per Admiralty charts of the St. Lawrence and the St. Lawrence Pilot.

For example, the Quebec time of high water in the forenoon of 12th October, 1887, No. 2 of series No. 1 of tides observed, was obtained thus, by Mr. McCallum:

Time of high water, afternoon, 11th October, at London Bridge.	<sup>H. M.</sup> 8 53
Add <sup>H. M.</sup> (6 38 — <sup>H. M.</sup> 2 7) or.....	4 31
Time of high water, Quebec, 12th October, forenoon, as per McCallum's tide table for 1887.....	1 24

## NOTE TO TABLE IV.

At all these stations the observations were made invariably by the time of longitude 75° west of Greenwich, known as "Eastern Standard." On the south shore of the St. Lawrence the observers could easily compare their watches once or twice a week, or more, with the station clocks or regulators of the Canadian Pacific Railway. At the Graving Dock, Chaudière and St. Nicholas stations, on the south shore, correct time was obtained from Quebec city nearly every day by telegraph, railway or steamboat. At Pointe Platin a properly regulated marine chronometer was relied on for supplying correct standard time, and at St. Jean des Châtillons the watch used was compared with this chronometer by telegraph twice a week. Besides which time was here also obtained twice a week from Quebec by steamboat. At the stations between Three Rivers and Montreal the time used was also kept as closely as possible coincident with "Eastern standard" by comparing the time-pieces with steamboat and railway clocks as often as practicable, on an average twice a week. It is believed that between Sorel and Quebec the maximum error in the time as corrected did not exceed one minute; above Sorel where accuracy was of much less importance, as at the tide stations further down stream, the error may reach 5 minutes.

This method is frequently followed in computing approximately the local time of high water in ports along the sea-coasts. I may remark, however, that as Mr. McCallum heads his tables "Standard Time," he should deduct 15 minutes from results such as the above, which would have reduced the last total to 1 9. But then, on the other hand, if the time, H. W. at F. & C., given in the Nautical Almanac for London Bridge, viz. : 1 58, had been used instead of 2 7, 1 18 would have been arrived at instead of 1 9. Moreover, the lunitidal intervals vary also with the height of the river or the fresh water discharge, to the amount of some 15 minutes or more.

Again, the Quebec time of high water in the afternoon of May 27, 1888, No. 304, series No. VIII. of tides observed, was arrived at thus :

Time of high water, afternoon, 26th May, 1888, London Bridge.	H. M. 2 43
Add (6.38—2.7) or.....	4 31
Time of high water, Quebec, 27th May, evening, as per McCallum's tide table for 1888 .....	7 14

Here the London Bridge time of high water for a half day anterior to that which corresponds to the Quebec time sought, was apparently used for computing the time marked in Mr. McCallum's table.

It is, of course, quite possible that some of the times calculated by Mr. McCallum have been entered opposite the wrong dates, or in the wrong columns ; but which are properly and which wrongly entered cannot easily be made out.

On account of the great distance inland from the Atlantic coast to the port of Quebec—say 685 nautical miles—the tide wave, of which the summit reached Quebec city, 12th October, 1887, at about 1h. 24m. a.m., was, as already explained in another part of this report, one-half day older than the wave of which the summit passed London Bridge at 8h. 5m. p.m., 11th October. Hence, for the purpose of transferring the tidal intervals computed for the port of London to the sea-port of Quebec, it becomes necessary: 1st. To increase the establishment of the last named port (Quebec)

by 12 25, the average duration of a half tide day, which brings the establishment in question—say to  $(6.24 + 12.25) = 18.49$  for the low water season, and to  $(6.09 + 12.25) = 18.34$  for the high water season ; 2nd. To add from  $(18.49 - 1.58) = 16.51$  to  $(18.34 - 1.58) = 16.36$  to the computed time of high water at London Bridge taken from the Nautical Almanac, either for the first half day preceding that for which the time of high water at Quebec is sought, or for the second half day previous to the said Quebec time, if found requisite in order to go back a full half day beyond the first anterior London time of high water ; 3rd. To add, say 10 minutes for the 5 hours difference of longitude west from London to Quebec ; 4th. To subtract 15 minutes from the local time so obtained to convert it into eastern standard time. A rational mode of determining approximately the eastern standard time of high water at Quebec, for 12th October, in the forenoon, by using the ordinary establishments of the ports of London and Quebec, in connection with data from the tide tables of the Nautical Almanac, is as follows :—

Time of high water, forenoon 11th October, 1887, at London Bridge.....	H. M. 8 10
Add $(6.38 + 12.25 + 0.10) - (1.58 + 0.15) =$ .....	17 00
	25 10
Deduct .....	24 00
Approximate standard time, high water at Quebec, 12th October, a.m.....	1 10

We can, however, arrive at more satisfactory results by using the mean luni-tidal intervals for different seasons of the year in connection with the times of high water, calculated either for London Bridge or some other European port.

The second of the three series of eastern standard times of high water, entered in the Tables of tidal fluctuations at the Graving Dock, is based on the times of high water which are given in "L'Annuaire des Marées" for the port of Brest in France. To these times corrections have been applied, in the vicinity of the quadratures, as was shown to be necessary, by Mr. Gaussin, a celebrated French hydrographic engineer, who made searching investigations in reference to this matter.

The difference between the mean luni-tidal intervals of the ports of Brest and Quebec increased by 12 <sup>H. M.</sup>25, plus 10 <sup>M.</sup> increase in time of moon's meridian passage for nearly 5 hours difference of longitude west, and less 15 minutes difference between Quebec (local) and Eastern standard times, 6 <sup>H. M.</sup>24—3 <sup>H. M.</sup>24 + 12 <sup>H. M.</sup>25 + 10 <sup>M.</sup>—15 <sup>M.</sup> = 15 <sup>H. M.</sup>20, has been added in each case to the time of H.W. at Brest, taken for the half day anterior to that which corresponds to the time sought for Quebec.

Taking again the forenoon tide of 12th October, 1887, as an example, we have :

Time H.W. at Brest, forenoon, 11th October, 1887.....	<sup>H. M.</sup> 10 0
Add (6 <sup>H. M.</sup> 24 + 12 <sup>H. M.</sup> 25 + 0 <sup>H. M.</sup> 10)—(0 <sup>H. M.</sup> 15 + 3 <sup>H. M.</sup> 25) or.....	<sup>H. M.</sup> 15 19
	<hr/>
	<sup>H. M.</sup> 25 19
Deduct .....	<sup>H. M.</sup> 24 0
Standard time H.W., Quebec, 12th October, A.M.....	<sup>H. M.</sup> 1 19

The times computed in this manner agree best, on the whole, with the observed times of high water at Quebec and the other tide stations.

By substituting the London Bridge times of the Nautical Almanac, which have been corrected for semi-monthly inequalities by the Hydrographic Office, for the Brest time of high water, and using the corresponding mean luni-tidal interval, viz., 1 <sup>H. M.</sup>26 in place of 3 <sup>H. M.</sup>25, we arrive at the time of high water of the same forenoon tide, as follows :—

Time of H.W. at London Bridge, forenoon, 11th Oct., 1887.....	<sup>H. M.</sup> 8 10
Add (6·24 + 12·25 + 0·10)—(0·15 + 1·26), or.....	<sup>H. M.</sup> 17 18
	<hr/>
Total.....	<sup>H. M.</sup> 25 28
Deduct .....	<sup>H. M.</sup> 24 0
	<hr/>
Standard time H.W., Quebec, 12th October, A.M.....	<sup>H. M.</sup> 1 28

As already stated, in computing the times of H.W. during the high water season, it is evidently requisite to use the corresponding mean luni-tidal intervals : these are from 10 to 20 minutes smaller than those which obtain during the low water season at all points between Quebec and St. Jean des Chaillons inclusive, above which place they appear to be greater ; but this apparent excess may be due to irregular fluctuations caused by winds and freshets.

In passing from the very high stage of the river in the spring to low water in the fall, the mean luni-tidal intervals which obtain at the gauging stations of the St. Lawrence should be gradually increased as far up as St. Jean des Chaillons, say in direct proportion to the relative decrease in the elevation of the river at Verchères.

Although the computed times entered in the tables of tidal fluctuations may be considered to agree, on the whole, sufficiently well with the actual or observed times of high water for most practical purposes, the concordance cannot be called perfect ; the disagreement between the two sets of times being especially noticeable about the times of

the moon's quadratures. Greater precision can be arrived at in the preparation of high water time tables by employing for the computation of the said times, the formula :

$$H = p + C + E - 19 \text{ minutes,}$$

where :

H denotes the time of high water sought,

p denotes the time of the meridian passage of the moon at the port under consideration immediately preceding the time H,

C denotes a function of the distance of the sun and moon from the earth, the declinations of the said heavenly bodies, and the difference between their right ascensions which obtains  $1\frac{1}{2}$  days previous to the passage corresponding to p, and

E denotes the establishment of the port.

In order that the more accurate results referred to may be successfully calculated with the aid of the above formula, it is necessary to have at one's disposal continuous series of reliable observations such as those made in 1887-88, extending over a number of seasons.

In the meantime, the times of high water computed, as above indicated, may be corrected with some benefit according to the empirical rule laid down hereunder which has been deduced from diagrams Nos. IV and V.\*

These diagrams were constructed as follows, with the aid of the data available :— The lengths of the semi-tide days, H. W. to H. W., according to the times of high water printed in "L'Annuaire des Marées" for the port of Brest, which, as already stated, appear, on the whole, to agree best with the times observed at the Graving Dock gauging station, were laid down consecutively as abscissas along a right line to a scale of 40 hours per inch, and the differences between the said observed St. Lawrence times of H. W. and the computed times based on those calculated for Brest and London Bridge were plotted as rectangular ordinates; one inch being allowed for 20 minutes. On account of the smallness of the scale, the same abscissas could be used without perceptible error, in connection with the St. Lawrence times of high water based on the London Bridge times, as well as in connection with those based on the Brest time.

The diagrams show :

1st. That the greatest diurnal differences between the computed and observed times of high water, arising from the daily variations in the action of the moon when not in the equator—which are usually not taken into account in computing such times—amounts, in the low water season, to 36 minutes at Quebec (see Nos. 12 $\frac{1}{2}$  and 13, Series No. 11, of tidal fluctuations at Graving Dock, Appendix No. 13), and to 55 minutes at Batiscan (see Nos. 13 and 13 $\frac{1}{2}$  for Batiscan, Appendix No. 13), and, in the high water season, to 41 minutes at Quebec (see Nos. 36 and 36 $\frac{1}{2}$  for Graving Dock, Appendix No. 13), and 83 minutes at Batiscan (see Nos. 17 $\frac{1}{2}$  and 18 for Batiscan, Appendix No. 13); the tide attaining its full height sooner when the amplitude is greater and later, when it is less than that of the mean semi-diurnal wave.

2nd. That on the days of quadrature, or one day ahead or one day after the said days, the observed times are from 20 to 60 minutes greater or later than the computed ones, the whole of which difference, rolled up in from two to three days, disappears again in a similar short space of time. Also, that during the remainder of the lunar month, viz., from about one day preceding one quadrature up to within a day or so of the following one, the observed times are, on an average, from 5 to 15 minutes smaller than the computed ones or in advance of the same, on an average, from say 5 minutes at Quebec during the high water season, to 15 minutes at Batiscan during the low water season.

The approximate times computed for the Graving Dock station, harbour of Quebec, may be amended by applying directly the following empirical rule, based on the rectilinear loci of average high tide hours drawn in red on diagram No. IV, and those calculated for stations to the westward of Quebec can also be amended with some advantage by

\* Full size lithographs of these diagrams are annexed to official report for 1890-91.

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applying the corrections indicated below to the times of the tides which correspond, as shown by the reference numbers to the particular Quebec tides pointed out in the said rule. (See diagram No. V, for Batiscan station.)

To correct the approximate Graving Dock times of high water :

1st. Retain without change the third and fourth times, (such as Nos. 12 and  $12\frac{1}{2}$  in table No. V, which here follows, and in table I of Appendix No. 13), preceding the instant of quadrature of the moon, as well as the sixth and seventh succeeding times of high water (such as Nos. 16 and  $16\frac{1}{2}$ ).

2nd. Add to the seven intervening times (Nos. 12 to 16) taken consecutively from either end, 8, 16, 24, 24, 24, 16 and 8 minutes.

3rd. Deduct 6 minutes from all the following times up to the fourth anterior to the next quadrature, exclusive (Nos. 17 to  $26\frac{1}{2}$ ).

The results obtained by making such corrections are shown hereunder in the cases of the Graving Dock and Batiscan tide-gauging stations, for the low and high water seasons.

TABLE V.

LOW WATER, SEASON OF 1887.						Number of high water, Appendix No. 13.	HIGH WATER, SEASON OF 1888.					
Graving Dock Station.			Batiscan Station.				Graving Dock Station.			Batiscan Station.		
Corrected times of high water.	Difference between observed and computed approximate times.	Difference between observed and computed corrected times.	Corrected times of high water.	Difference between observed and computed approximate times.	Difference between observed and computed corrected times.		Corrected times of high water.	Difference between observed and computed approximate times.	Difference between observed and computed corrected times.	Corrected times of high water.	Difference between observed and computed approximate times.	Difference between observed and computed corrected times.
H. M.	Min.	Min.	H. M.	Min.	Min.		H. M.	Min.	Min.	H. M.	Min.	Min.
10 10	3	3	1 33	3	3	-1						
10 39	11	3	2 2	21	8	1 1/2						
11 11	6	10	2 35	3	13	0						
11 46	5	4	3 10	44	20	1/2						
12 19	12	12	3 43	4	20	1						
12 57	35	11	4 21	36	22	1 1/2						
1 35	5	11	4 59	15	1	2						
2 14	15	17	5 37	25	17	2 1/2						
2 49	11	11	6 12	5	5	3						
3 25	8	8	6 51	14	14	3 1/2						
3 55	12	12	6 56	24	4	4						
4 24	5	1	7 47	8	2	4 1/2	9 30	7	7	1 21	31	31
4 50	12 1/2	2 1/2	7 13	16	10	5	9 54	2	2	1 45	7	7
5 15	12 1/2	4 1/2	8 28	28	20	5 1/2	10 24	13	5	2 19	12	4
5 48	12	15	8 1	9	11	6	11 3	15	1	2 54	1	17
6 6	12 1/2	2 1/2	8 23	1	7	6 1/2	11 42	29	5	3 33	29	15
6 15	12	7	8 45	4	2	7	12 16	7	17	4 7	30	6
6 44	11	5	10 7	8	3	7 1/2	12 34	47	23	4 45	39	35
7 1	6	5	10 28	28	14	8	1 28	12	4	5 19	34	18
7 35	12	8	10 30	11	5	8 1/2	2 16	31	23	5 53	46	29
7 58	4 1/2	11	11 11	6	3	9	2 38	1	1	6 26	19	19
8 10	12	8	11 23	9	6	9 1/2	3 12	11	11	7 3	50	26
8 42	8	8	11 35	8	6	10	3 42	1	7	7 29	17	23
9 14	5	1	12 16	8	12	10 1/2	4 3	1	5	7 56	27	33
Total	274	174	342	258	158		177	111		372	286	

TABLE V.—Continued.

LOW WATER, SEASON OF 1887.						Number of high water, Appendix No. 13.	HIGH WATER, SEASON OF 1888.					
Graving Dock Station.			Batiscan Station.				Graving Dock Station.			Batiscan Station.		
Corrected times of high water.	Difference between observed and computed approximate times.	Difference between observed and computed corrected times.	Corrected times of high water.	Difference between observed and computed approximate times.	Difference between observed and computed corrected times.		Corrected times of high water.	Difference between observed and computed approximate times.	Difference between observed and computed corrected times.	Corrected times of high water.	Difference between observed and computed approximate times.	Difference between observed and computed corrected times.
H.M.	Min.	Min.	H.M.	Min.	Min.	H.M.	Min.	Min.	H.M.	Min.	Min.	
Over	274	174	.....	348	218	.....	.....	177	111	.....	372	296
9 15	9	6	12 38	10	4	11	4 31	8	13	8 21	31	37
9 43	1	0	1 6	14	14	11½	4 52	4	2	8 43	8	2
10 6	18	18	1 29	3	3	12	5 12	3	3	9 3	13	19
10 30	{ 3 }	11	2 2	22	14	12½	5 30	11	5	9 21	10	4
11 14		33	17	2 37	{ 70 }	+ 54	13	5 48	4	2	9 39	6
11 52	2	22	3 15	{ 15 }		9	13½	6 4	6	0	9 55	30
12 26	33	9	3 49		35	11	14	6 21	3	3	10 12	20
1 6	21	7	4 29	20	4	14½	6 36	9	3	10 27	44	38
1 42	24	8	5 5	69	53	15	6 52	3	3	10 43	13	7
2 21	10	2	5 44	20	12	15½	7 7	8	2	10 58	38	32
2 54	23	23	6 17	37	37	16	7 23	1	5	11 14	9	15
3 31	0	0	6 54	2	2	16½	7 38	11	5	11 29	50	44
3 56	5	1	7 19	5	1	17	7 54	8	2	11 45	6	0
4 23	9	6	7 46	12	6	17½	8 10	10	4	12 1	{ - 38 + 47 }	32
4 49	8	5	8 9	5	11	18	8 26	10	4	12 17		+ 53
5 7	0	6	8 30	13	7	18½	8 42	18	12	12 33	19	13
5 26	4	2	8 49	4	2	19	9 0	8	2	12 51	46	52
5 43	5	1	9 6	12	6	19½	9 18	16	10	1 9	1	7
6 0	18	12	9 23	26	20	20	9 43	+ 4	4	1 34	32	32
6 16	33	26	9 39	19	13	20½	10 5	7	7	1 56	15	15
6 31	22	16	9 54	20	14	21	10 37	12	4	2 28	62	+ 54
6 47	13	7	10 10	13	7	21½	11 11	1	15	3 2	33	17
7 1	13	7	10 24	17	11	22	11 49	18	6	3 40	47	23
Forw'd	581	386	.....	806	533	.....	.....	360	227	.....	900	842

TABLE V—*Concluded.*

LOW WATER, SEASON OF 1887.						Number of high water, Appendix No. 13.	HIGH WATER, SEASON OF 1888.					
Graving Dock Station.			Batican Station.				Graving Dock Station.			Batican Station.		
Corrected times of high water.	Difference between observed and computed approximate times.	Difference between observed and computed corrected times.	Corrected times of high water.	Difference between observed and computed approximate times.	Difference between observed and computed corrected times.		Corrected times of high water.	Difference between observed and computed approximate times.	Difference between observed and computed corrected times.	Corrected times of high water.	Difference between observed and computed approximate times.	Difference between observed and computed corrected times.
H. M.	Min.	Min.	H. M.	Min.	Min.	H. M.	Min.	Min.	H. M.	Min.	Min.	
Over	581	386	806	533			360	227	990	842		
7 16	7	1 10 39	8	14		22 12 23	12	12	4 14	46	22	
7 31	18	12 10 54	12	6		23 1 1	13	11	4 52	48	24	
7 46	7	1 11 9	6			23 1 33	5	21	5 24	27	11	
8 2	12	6 11 26	15	9		24 2 4	10	2	5 55	40	32	
8 17	2	8 11 40	1	5		24 2 33	5	5	6 24	21	21	
8 33	16	10 11 38	17	11		25 3 7	5	5	6 58	22	23	
8 49	2	4 12 12	17	23		25 3 32	8	2	7 23	11	17	
9 7	10	4 12 30	16	10		26 4 0	10	4	7 51	12	6	
9 24	14	20 12 47	22	22		26 4 26	8	2	8 17	10	4	
9 30	8	8 1 13	1	1		27 4 51	10	4	8 42	30	24	
						27 5 15	3	3	9 6	15	9	
						28 5 30	10	4	9 30	39	33	
						28 6 3	5	1	9 54	25	19	
						28 6 26	7	1	10 17	53	47	
						28 6 49	4	10	10 49	8	2	
						29 7 13	11	5	11 4	57	51	
						29 7 36	2	8	11 27	24	18	
						31 4 0	10	4	11 51	45	39	
						31 4 24	1	7	12 15	14	8	
						32 4 47	3	3	12 38	22	26	
						32 5 10	9	15	1 1	11	17	
Totals.	677	460	931	650			311	366	1580	1294		
Means.	12	8	16	11			4	64	26	23		

On account of the disturbances caused by winds, in the regular propagation of the tidal undulations in the St. Lawrence estuary, the crests of these waves passed the Graving Dock several times from 20 to 25 minutes earlier or later than indicated by the corresponding computed times of high water even with corrections applied, and at Batiscan the irregularities in the passages of the successive wave summits due to winds are much greater; the discrepancy between the observed and the corresponding corrected computed time having reached in five cases, 50 to 54 minutes.

The mean differences, however, between the observed and the corrected computed times of high water at the Graving Dock and Batiscan, are but 8 and 11 minutes respectively, for the low water season, and 6 and 23 minutes for the high water season, while the mean differences between the observed and the uncorrected approximate computed times are respectively 13 and 16 minutes and 9 and 28 minutes; the ratios between the corresponding mean differences at the two places being thus respectively :

$$\frac{8}{13} = 0.61 \text{ and } \frac{11}{16} = 0.69, \text{ and } \frac{6}{9} = 0.66 \text{ and } \frac{23}{28} = 0.82.$$

As morning tides are generally more important than evening tides during the month of May, and lower or smaller in October, it follows from the remarks just made, the indications of the diagrams and the figures given in the last table, No. V., that a day or two after the moon has reached her maximum declination, or thereabouts, owing to the diurnal inequalities high water may occur in the normal order of things during the month of May, at Quebec some 20 minutes, and at Batiscan some 40 minutes earlier in the morning than the hour that would be marked in a table of computed times, and respectively some 20 and 40 minutes later in the case of evening tides, even with corrections applied as above suggested. Also for the same reason the tide may attain its full height in the said localities respectively some 18 and 28 minutes later in the morning and earlier in the afternoon during the month of October. It will be noticed, that as we proceed westward from Quebec, the diurnal inequalities in the priming or lagging of the tides go on increasing, and the irregularities in the propagation of the summits of the fluvial waves, as well as in the advance of the head of the flood, also become greater; moreover, these differences and irregularities are larger during the high than during the low water season. By taking into consideration, in each case, the variations in the times of high water which are caused by changes in the volume of the fluvial discharge, and modifying the rule above laid down for the correction of the approximate times determined for the Graving Dock station accordingly, we might approach, on the whole, closer to the true times for any particular place on the upper portion of the estuary, where this might be considered to be desirable, than can be done by applying uniformly the said rule as it stands in each locality.

The preparation of reliable tide tables for the use of navigators frequenting the St. Lawrence and others is a matter of sufficient importance to be taken up by the Dominion Government. The annual expenditure of issuing a sufficient number of tide tables constructed as outlined above, for the season of navigation, to meet present requirements would not be large.

It may not be superfluous to recall, that the tidal coefficients called "centièmes," which are published every year in "L'Annuaire des Marées de France" represent the proportional semi-amplitudes of the semi-diurnal luni-solar tide waves; the diurnal, monthly and annual undulations being left out of consideration and the semi-amplitude of the tide, or elevation of high water above or depression of low water below the mean tide level at the time of a syzygy such, that both the moon and sun are on the equator and at their mean distances from the earth, being taken as unity or 1.

The actual semi-amplitude of the tide wave in a seaport at the time when the sun and moon are in the positions just described, is termed "the unit of height" of this port. The units of height are used by masters of vessels in the seaports of France and elsewhere in conjunction with astronomical tidal coefficients (centièmes), principally for ascertaining on any given date the rise or fall of the tide, reckoned from the mean sea level.

If some one had attempted to determine at Quebec, the position of the high or low water level for the morning tide of 11th October, 1887, at low neaps, the coefficient of which is 41, by using the average value of the unit of height during the lunar month from 12th October to 10th November, which is 9.50 ft. nearly, he would have made out low water to stand  $41 \times 9.50 = 3.895$  ft. below and high water 3.895 ft. above the mean tide level of that day. But according to actual observation, high water at 12.07 a.m., 11th October, 1887, was 6.765 ft. above and the preceding low water 5.69 ft. below the mean tide level corrected for diurnal inequalities; the computed elevations would therefore have been respectively 2.87 ft. and 1.80 ft. in error.

Again, if corresponding determinations of high and low water levels had been made for the afternoon tide of 18th October, at high springs, having a coefficient of 117, low and high water would have been found to stand respectively:  $117 \times 9.50 = 11.115$  below and 11.115 above the corrected mean tide level, while in reality, low water observed at 2.42 p.m., 18th October, was but  $(10.720 - 2.066) = 8.65$  ft. below and the high water immediately following  $(20.182 - 10.720) = 9.46$  ft. above the said mean tide level; the errors being respectively 2.46 ft. and 1.65 ft.

Such computations would seldom prove of any practical utility at Quebec, on account of fluctuations of the mean tide level being too irregular; they serve here to show that even supposing the elevation of the said mean tide level to be accurately known the errors that would be committed are, in the case of neaps, nearly 9 and 20 per cent, and in the case of springs 64 and 10 per cent greater than the errors which have been found to obtain in European seaports under the most unfavourable conditions of wind and weather, although during the whole time the observations were made in 1887-88, and for several days previous, the weather was fair and no high winds were felt at Quebec and vicinity.

These large discrepancies appear to be chiefly due to the following causes:

1st. At spring tides the whole body of water brought up the St. Lawrence estuary by the Atlantic wave has to be raised vertically several feet higher than at neap tides, and as a good portion of the energy of the fluvial undulation is expended in performing this work, the intumescence formed on the estuary must gain less rapidly in importance than the wave from the ocean that gives rise to it.

2nd. At neaps the volume of tide water retained in the estuary—which may be looked upon as a very long narrow pond—is smaller than at springs, and the general level corresponding to any one whole phase of the undulations which are continuously being propagated up the St. Lawrence, is therefore lower than at springs and the importance or amplitude of the tides comparatively greater, than the theoretical one based on the coefficients (centièmes) contained in “*L'Annuaire des Marées*.”

That the volume of tide water which lodges in the estuary increases with the gaining tides and diminishes when these are losing in importance, is shown in a striking manner by illustrations Nos. III.\*, VI.\*, IX.\*, X., XII., XIII., XIV.\*, XIX.\*, XX., XXI., and XXII., on which are indicated the vertical movements of the tidal undulations at Grondines, St. Jean, Batiscan and Champlain. At these places the St. Lawrence invariably falls to a lower level at neaps than at springs, while the fresh water discharge and river level at Verchères remain constant. Below Pointe Platon, the low water surface of the stream is generally at a higher level at neaps than at springs; but on the whole the filling and emptying of the estuary goes on according to the same law as above this point, which is plainly indicated by illustrations Nos. III.\*, VI.\*, VII., VIII., XII., XIII., XVII. and XVIII. and also by the figures contained in tables of tidal fluctuations Nos. I. to IV. and X. to XIII. of Appendix No. 13.

On all of the tidal diagrams, viz., Illustrations Nos. VI.\* to XV.\*, the high, low and mean tide levels observed in 1887-88 during the low and high stages of the river, are plotted in chronological order, together with three corresponding series of tide levels corrected for diurnal inequalities as also approximate rectilinear loci DA, DC, DE for the last three series of levels just mentioned. The observed high, low and

\* Lithograph full size to accompany official report of Minister of Public Works for fiscal year 1890-91.

mean tide levels are connected by full lines, and those corrected for diurnal inequalities by dashes alternating with two dots.

On diagram No. VI., viz., that indicating the elevations of the wave summits and troughs and the mean tide levels observed at the Graving Dock during the low water season in the autumn of 1887, are shown in addition to the loci DA, DC, DE just referred to: 1st. Rectilinear loci (compensation lines)  $\bar{D}A$ ,  $\bar{D}C$ ,  $\bar{D}E$ , of three corresponding series of tide levels (connected by dotted lines) further corrected by variations in the pressure of the atmosphere above and below the mean pressure which obtained 9th October to 10th November, the time during which observations were made, viz., a pressure corresponding to that created by a column of mercury 29.96 inches high. 2nd. High and low water curves indicating the fluctuations of theoretical tide waves due to astronomical causes only, viz., in full red lines. In constructing these curves I have given to the ratio  $\frac{AB}{AC}$  of AB, the height of high water mark A above the level BD which the stream would assume approximately if it was abstracted from the influence of the tides, to the whole amplitude AC, and to the ratio  $\frac{BC}{AC}$  of BC, the depth to which low water descends below the said level BD to the amplitude AC, the approximate values of about  $\frac{2}{3}$  and  $\frac{1}{3}$  respectively.

By drawing accurate compensation lines AB, BD, with the aid of the planimeter in connection with the high and low water loci corrected for diurnal inequalities only, for each one of the four series of gaining and losing tides Nos. I., II., III. and IV. of the complete cycle for the lunar month from 12th October to 10th November, 1887, the following mean values of the said ratios more correctly applicable in each case, have been arrived at, viz.:-

For series No. I.,	$\frac{AB}{AC} = 0.829$	$\frac{BC}{AC} = 0.171$
do II., do	$= 1.015$	do $= 0.015$
do III., do	$= 0.705$	do $= 0.295$
do IV., do	$= 1.176$	do $= 0.176$

Mean values for the four series:  $\frac{AB}{AC} = 0.937$ ,  $\frac{BC}{AC} = 0.067$ , or say  $\frac{1}{2}$  and  $\frac{1}{17}$  respectively.

Moreover, the mean level of the tideless estuary corresponding to the period just described was, for the purpose of constructing the astronomical tide curves, placed about 1.85 feet above datum, so as to occupy an intermediate position between the four river levels determined by the intersections  $D_1$ ,  $D_2$ ,  $D_3$ ,  $D_4$  of the compensation lines drawn in connection with the high and low water loci corrected for diurnal inequalities, but not for variations in the atmospheric pressure, nor for fluctuations in the fresh water discharge. These river levels are at the following elevations above datum, viz.,  $D_1B_1$ , 3.20 feet;  $D_2B_2$ , 1.80 feet;  $D_3B_3$ , 6.42 feet; and  $D_4B_4$ , 0.42 feet, the mean of which is 2.96 feet, and with corrections applied for variations of atmospheric pressure above and below the average pressure of 29.95 inches of mercury, the said river levels were found to be 3.17, 1.98, 6.10 and 0.40 feet above datum, the mean of which is 2.91 feet, viz., only 0.05 feet less than that deduced from the loci of the tide levels uncorrected for changes in the barometric column. Finally, the unit of height for computing the amplitudes of the astronomical tides at Quebec for the low water season of 1887 has been taken at 9.515 feet, which is the mean value of the same for the complete lunar month, 9th October to November, 1887.

In the construction of the high and low water curves indicating the variations of the theoretical tide waves, viz., those due exclusively to astronomical causes during the high water season and which are shown in red on diagram No. XII., the mean level  $\bar{B}D$  of the tideless stream was placed at an elevation of 3.22 feet =  $\frac{2.34 + 3.20 + 3.34 + 3.40}{4}$ , which fraction denotes the mean of the average levels of the tideless estuary deduced for the

four series of observations Nos. V., VI., VII. and VIII. Moreover, the ratios  $\frac{AB}{AC}$  and  $\frac{BC}{AC}$  have been given the respective mean values which obtain in the said series of gaining and losing tides, viz.,  $\frac{AB}{AC} = \frac{0.910 + 0.797 + 0.730 + 0.745}{4} = 0.7955$  and  $\frac{BC}{AC} = \frac{0.090 + 0.203 + 0.270 + 0.255}{4} = 0.2045$  and the mean unit of height used for com-

puting the theoretical amplitudes is 9.32 feet, which was its mean value during the same four series of tides.

The sinusoidal curves of theoretical tide levels for the low water season of 1887 which are drawn on illustration No. VI. for the Graving Dock station, show at a glance, that at springs the actual high tide level is from 2.0 to 3.5 feet lower in Quebec Harbour than the theoretical one determined as above explained, and at neaps from 2.5 to 4 feet lower; but as regards low tide, the relative positions of the theoretical and natural loci of water levels are not so well defined or easily made out. The irregularities in the natural low tide locus are so marked and numerous and the typical astronomical low water sinusoidal curve so flat that it is difficult, in many places, to determine in a positive manner, whether the latter locus is higher or lower than the former.

It is not impossible that the interference of the wave passing through the Straits of Belle Isle into the Gulf of St. Lawrence, with that which enters through Cabot Strait, may, to some extent, be instrumental in bringing about the flattening, just pointed out, of the theoretical high and low water curves which indicate the variations due to astronomical causes, in the importance of the tide waves on the shores of the open Atlantic, and in the vertical positions of the summits and troughs of the said waves.

Table VI. Maximum, minimum and mean results of monthly series of tidal observations made during the high and low water seasons of 1887-88, with river at respective elevations of 21.94 feet and 29.91 feet above datum at Verclères respectively.

8-7\*

	LAVIN GRAVING DOCK.		ST. NICHOLAS.		POINTE PLATON.		GRONDINES.		ST. JEAN DES-CHAILLONS.		BATIGNAN.		CHAMPLAIN.	
	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.
Maximum duration of floods observed.....	5 39	6 18	5 46	5 20	5 23	4 40	5 00	4 02	4 39	3 58	4 38	4 38	5 15	4 38
Minimum do.....	4 11	4 14	4 35	4 30	4 01	3 20	3 32	3 12	3 25	3 03	3 00	2 40	2 40	2 43
Mean do.....	4 59	4 45	5 0	4 53	4 29	4 04	4 14	3 35	4 05	3 27	3 37	3 47	3 35	3 39
Maximum duration of ebbs observed.....	8 07	8 21	8 9	8 20	8 26	9 03	8 53	9 47	9 16	9 50	9 46	9 55	10 00	10 13
Minimum do.....	6 47	6 54	6 42	6 50	7 05	7 40	7 24	8 00	7 23	8 12	7 37	7 07	7 20	7 20
Mean do.....	7 28	7 40	7 26	7 32	7 47	8 22	8 12	8 50	8 21	8 58	8 49	8 37	8 47	8 45
Maximum length of half tide day (H. W. to H. W.) observed.....	13 05	13 12	13 15	13 00	13 08	13 10	13 10	13 08	13 06	13 09	13 33	13 23	13 20	13 25
Minimum do.....	11 58	11 57	11 50	11 55	11 54	11 55	11 55	11 48	11 51	11 48	11 35	11 10	11 35	11 28
Mean do.....	12 26	12 25	12 25	12 25	12 25	12 25	12 26	12 25	12 25	12 25	12 25	12 25	12 25	12 25
Maximum difference between observed and computed half tide day	36	41	48	33	41	33	43	42	52	45	55	1 25	57	1 02
Mean do.....	13	11	14	15	12	13	11	21	11	20	18	29	21	23
Maximum observed priming of tides.....	32	26	31	25	27	35	29	25	29	25	38	43	1 15	42
do lagging of tides.....	53	29	51	40	54	35	51	29	47	25	1 04	38	1 20	52
Mean of observed priming and lagging of tides.....	16	12	20	12	18	12	18	13	20	12	19	19	33	16
Maximum difference between observed and computed priming of tide.....	27	12	29	14	38	16	38	21	20	23	42	53	1 02	33
do do lagging of tide.....	51	19	49	23	52	18	49	19	42	23	1 07	26	52	31
Difference between mean of observed and mean of computed priming and lagging of tides.....	01	00	00	00	00	00	60	00	00	00	04	07	05	04
Maximum diurnal inequalities in priming or lagging of observed tides.....	1 25	28	1 22	1 0	1 12	30	1 7	22	56	20	1 30	1 9	1 50	57
Mean do.....	17	08	19	16	18	10	17	8	18	10	26	22	20	19
Diurnal inequalities in computed priming or lagging corresponding to maximum inequalities observed.....	7	10	7	6	7	17	7	6	7	9	12	1	3	16
Difference between maximum observed and corresponding computed inequalities.....	1 18	18	1 15	54	1 5	13	1 0	16	49	20	1 18	1 8	1 47	41

TABLE VI.—Maximum, minimum and mean results obtained during the high and low water seasons of 1887-88, &amp;c.—Continued.

	LEVIS GRAVING DOCK.		ST. NICHOLAS.		POINTE PLATON.		GRONDIENES.		ST. JEAN DES-CHAILLONS.		BATISCAN.		CHAMPLAIN.	
	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.
Difference between mean observed and mean computed or theoretical inequalities (6 to 7 minutes) in priming or lagging.....	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Maximum duration of apparent stand at high water—within. 0 05	10	02	12	10	11	04	10	02	11	04	19	16	13	13
Minimum do do 0 05	31	37	36	.....	32	34	33	1 00	41	25	1 44	2 10	2 00	2 30
Mean do do 0 05	13	10	6	.....	7	09	20	18	16	15	17	35	16	20
Maximum duration of apparent stand at low water—within. 0 05	22	25	19	.....	21	21	26	32	28	37	42	1 26	45	1 00
Minimum do do 0 05	32	36	55	.....	26	36	35	1 05	56	1 14	1 30	2 25	2 50	2 05
Mean do do 0 05	12	11	4	.....	10	10	21	32	13	20	02	28	15	20
General duration of apparent stand at high and low water—within..... 0 05	19	20	18	.....	17	22	27	45	31	49	57	1 16	1 10	1 04
Elevation of highest wave summit observed.....	18 397	20 184	17 480	20 969	18 670	23 051	18 340	23 827	18 484	24 380	18 746	25 248	19 253	25 920
do lowest wave trough observed.....	-1 321	0 500	0 570	2 137	6 357	6 640	13 017	9 219	15 940	13 019	14 469	19 353	14 353	20 070
Mean elevation of summits and troughs of waves observed.....	7 007	8 911	7 488	10 318	9 306	13 621	11 900	18 018	13 201	19 900	15 149	22 524	16 061	23 740
Maximum flood range observed.....	18 915	17 775	17 590	16 700	15 128	13 825	9 684	7 310	7 655	5 130	4 383	2 617	3 800	1 980
Minimum do do.....	9 351	10 126	9 550	9 680	8 930	7 030	4 972	2 190	3 540	1 200	1 690	0 430	0 450	0 140
Mean do do.....	13 869	13 288	13 400	12 768	11 767	10 439	7 502	4 704	5 390	2 960	2 532	1 262	1 869	0 950
Maximum ebb range observed.....	18 351	17 845	16 960	16 640	14 320	13 585	8 965	7 170	7 190	4 730	3 858	2 547	3 100	1 760
Minimum do do.....	9 326	9 547	9 630	9 230	8 800	6 993	5 175	2 366	3 455	1 350	1 204	0 626	0 800	0 150
Mean do do.....	13 835	13 268	13 380	12 572	11 746	10 452	7 496	4 745	5 291	2 940	2 516	1 265	1 857	0 950
Maximum mean tide level (corrected for diurnal inequalities) observed.....	8 987	10 529	9 330	11 952	11 274	15 606	13 624	20 026	14 809	21 420	16 610	23 982	17 434	25 310
Minimum do do.....	5 158	7 515	5 640	8 734	7 431	11 212	10 044	15 458	11 037	17 380	13 969	20 006	15 128	21 110
General do do.....	6 987	8 955	7 474	10 352	9 539	13 688	11 885	18 030	13 201	19 900	15 149	22 529	16 061	23 750
Maximum amplitudes corrected for diurnal irregularities corresponding to theoretical coefficients of 114 to 117 for L. W. season and coefficients 104 to 107 for H. W. season.....	17 088	16 441	16 410	15 418	14 010	12 602	8 515	6 325	6 844	4 250	3 763	2 000	3 225	1 430



TABLE VI.—Maximum, minimum and mean results obtained during the high and low water seasons of 1887-88, &c.—*Concluded.*

	LÉVIS GRAVING DOCK.		ST. NICHOLAS.		POINTE PLATON.		GRONDINES.		ST. JEAN DES-CHAILLONS.		BATISCAN.		CHAMPLAIN.	
	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.	Low water season.	High water season.
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Corresponding monthly mean times of low water.....	6 32	6 21	7 04	6 56	8 35	8 40	9 36	9 52	10 07	10 27	11 21	11 14	12 09	11 51
Maximum difference between observed time of high water and computed time based on Brest times corrected at quadratures by Mr. Gaussin, as given in "L'Annuaire des Mares".....	36	32	47	31	46	31	47	42	54	52	1 10	1 02	1 19	1 04
Minimum difference between observed time of high water and computed time based on Brest times corrected at quadratures by Mr. Gaussin, as given in "L'Annuaire des Mares".....	00	00	00	00	00	00	01	00	00	00	00	01	01	00
Mean difference between observed time of high water and computed time based on Brest times corrected at quadratures by Mr. Gaussin, as given in "L'Annuaire des Mares".....	13	09	12	11	11	10	11	14	12	15	18	27	21	20
Maximum difference between observed time of high water and computed time based on London Bridge tide tables contained in Nautical Almanac.....	1 01	1 01	1 00	54	58	47	1 08	59	1 20	1 04	1 38	1 16	1 41	1 29
Minimum difference between observed time of high water and computed time based on London Bridge tide tables contained in Nautical Almanac.....	00	00	05	00	00	01	00	01	00	00	01	03	02	01
Mean difference between observed time of high water and computed time based on London Bridge tide tables contained in Nautical Almanac.....	23	17	24	19	21	18	22	22	22	23	28	36	33	29
Discrepancy between the mean luni-tidal interval according to actual observation and that deduced from the computed times of high water based on the corresponding Brest times and the observed mean luni-tidal interval.....	00	00	1	1	3	2	3	3	4	4	4	5	4	5

REMARKS.—1. During the low water season of 1887 observations were made continuously from 11th October to 11th November, when the river stood at a mean elevation of 21.94 ft. at Verchères and 16.40 ft. over sill, old lock No. 1, Lachine Canal, and during the high water season of 1888, from 5th May to 3rd June, when the river surface was at a mean height of 29.91 ft. above datum at Verchères and 23.00 ft. over said lock sill.

2. Mean heights of barometrical column, reduced to sea level and 0° cent., or 32 Fahr. (a) QUEBEC: Mean of observations at Louis Graving Dock and those of Quebec Observatory, low water season of 1887, 30.0280 inches; high water season of 1888, 29.9440 inches. (b) MONTREAL (McGill Observatory): Mean of observations low water season of 1887, 30.0231 inches; high water season of 1888, 29.9431 inches.
3. Maximum height of reduced barometric column, Graving Dock, low water season of 1887, 30.618 inches; high water season of 1888, 30.586 inches.
4. Minimum height of reduced barometric column, Graving Dock, low water season of 1887, 29.241 inches; high water season of 1888, 29.586 inches.
5. Strongest winds observed { Quebec, low water season of 1887, S. E. wind 26.00 miles per hour; high water season of 1888, N. W. wind 17 miles per hour.  
 Montreal, low water season of 1887, westerly 72 miles per hour; high water season of 1888, S. W. wind 32 miles per hour.
6. Directions of prevalent winds - { Quebec, low water season of 1887, north-westerly; high water season of 1888, north-easterly.  
 Montreal, low water season of 1887, westerly; high water season of 1888, south-westerly.
7. In the 16 tables of tidal fluctuations for the high and low water seasons of 1887-88, Appendix No. 13, maxima are indicated by a star, thus : \*, and minima by a circle, thus : ○

N. B. Errors to be corrected in table of results of tidal observations of 1887-88, printed on Ill. XXVI. b, under the heading of Quebec Graving Dock.

Mean flood range observed	13.648	should be 13.879 as above.
do ebb	13.816	do 13.835
do diurnal difference in low water levels	460	do 484
General mean tide level corrected for diurnal inequalities	6.808	do 1.987

TABLE VII.—Mean rates of propagation of head of flood and summit of tide wave up the St. Lawrence, for each one of the series of gaining and losing tides observed, during a complete revolution of the moon in the low water season of 1887, viz. 12th October to 10th November; &c.

TIDE STATION.	Total and intermediate distance in miles.	Mean Duration of Flood, &c.	MEAN RATE OF ADVANCE OF TIDE WAVE IN MILES PER HOUR.					REMARKS.
			Series I.	Series II.	Series III.	Series IV.	General Mean of Four Series.	
			Gaining Tides.	Losing Tides.	Gaining Tides.	Losing Tides.		
			Tidal Coefficient = 81.57. Verchères river level = 22.01 ft.	Tidal Coefficient = 77.00. Verchères river level = 22.18 ft.	Tidal Coefficient = 68.40. Verchères river level = 21.77 ft.	Tidal Coefficient = 65.21. Verchères river level = 21.80 ft.	Tidal Coefficient = 72.95. Verchères river level = 21.94 ft.	
Graving Dock	0.00	H. M. 4 57	Miles.	Miles.	Miles.	Miles.	Miles.	M'n rate of advance of head of flood 11.6 miles greater than that of summit of wave between Graving Dock and River Chaudière. These rates of propagation obtained between the Graving Dock, instead of Riv. Chaudière and St. Nicholas. Mean difference between velocities of propagation of head of flood and summit: a minimum between Graving Dock and St. Nicholas = 1.85 mile per hour. Mean difference between velocities of propagation of head of flood and summit: a maximum between Platon and Grondines = 7.80 miles per hour.
		H'd of flood	35.00	35.96			35.40	
		Summit	23.17	23.31			24.11	
		Mean	29.17	29.64			29.76	
	8.33							
	13.52							
River Chaudière, East side	8.33	H. M. 5 04						
		H'd of flood	24.37	25.24	25.41	25.41	25.11	
		Summit	22.85	22.82	23.30	24.06	23.26	
		Mean	23.61	24.03	24.36	25.00	24.19	
	23.98							
St. Nicholas Baker's wharf	23.85	H. M. 5 01						
		H'd of flood	16.23	15.82	15.50	15.63	15.80	
		Summit	20.18	21.06	20.26	20.28	20.45	
		Mean	18.21	18.44	17.88	17.96	18.13	
	47.83							
Platon Hon. H. G. Joly's wharf	47.83	H. M. 4 35						
		H'd of flood	11.00	10.53	11.41	11.42	11.09	
		Summit	19.69	17.59	19.54	18.72	18.89	
		Mean	15.35	14.06	15.48	15.07	14.99	
	59.13							
Grondines Public wharf	59.13	H. M. 4 13						
		H'd of flood	9.45	10.76	11.01	9.09	10.08	
		Summit	13.08	13.61	18.29	13.24	14.56	
		Mean	11.26	12.18	14.65	11.17	12.32	
	64.33							
St. Jean des Chaillons Levasseur's wh'f.	64.33	H. M. 4 04						
		H'd of flood	7.04	6.31	5.96	6.02	6.33	
		Summit	11.56	10.41	9.74	9.75	10.40	
		Mean	9.30	8.36	7.85	7.89	8.35	
	72.08							
Batisca Brunelle's wharf	72.08	H. M. 3 37						
		H'd of flood	7.10		14.70	7.70	9.83	
		Summit	16.32		9.00	10.52	11.95	
		Mean	11.71		11.85	9.11	10.89	
	79.48							
Champlain Gagnon's wharf	79.48	H. M. 3 40						

TABLE VIII.—Mean rates of propagation of head of flood and summit of tide wave up the St. Lawrence, for each one of the series of gaining and losing tides observed, during a complete revolution of the moon in the high water season of 1888, viz., 4th May to 3rd June; etc.

TIDE STATION.	Total and intermediate distances in miles.	MEAN RATE OF ADVANCE OF TIDE WAVE IN MILES PER HOUR.					Remarks.
		Mean Duration of Flood, etc.	Series V.	Series VI.	Series VII.	Series VIII.	
			Gaining Tides.	Losing Tides.	Gaining Tides.	Losing Tides.	
			Tidal Coefficient = 65.14.	Tidal Coefficient = 67.18.	Tidal Coefficient = 78.00.	Tidal Coefficient = 75.71.	
			Verchères river level = 28.13 ft.	Verchères river level = 29.82 ft.	Verchères river level = 31.50 ft.	Verchères river level = 30.21 ft.	Verchères river level = 29.31 ft.
		H. M.	Miles.	Miles.	Miles.	Miles.	Miles.
Graving Dock...	0.00	4 44					
		H'd of flood	26.50				26.01
	8.33	Summit...	20.10				16.71
		Mean...	23.30				21.36
River Chaudière East side...	13.32	4 48					
		H'd of flood	23.81	22.90	23.18	23.49	23.37
		Summit...	23.08	18.24	17.91	17.52	19.19
		Mean...	23.44	24.62	24.55	20.50	21.28
St. Nicholas Baker's wharf.	53.85	4 53					
		H'd of flood	14.11	13.68	13.75	13.69	13.81
	28.46	Summit...	24.72	29.85	26.43	25.24	26.56
		Mean...	19.42	21.76	20.09	19.47	20.18
Platon. Hon. H. G. Joly's wharf.	47.83	4 03					
		H'd of flood	9.14	9.78	9.14	9.49	9.39
	11.30	Summit...	14.95	13.42	15.46	18.26	15.52
		Mean...	12.04	11.60	12.30	13.87	12.46
Grandline Public wharf	59.13	3 35					
		H'd of flood	9.73	8.04	9.64	9.23	9.16
	6.29	Summit...	14.32	10.71	11.74	12.34	12.28
		Mean...	12.03	9.38	10.69	10.79	10.72
St. Jean des Chaudières Lavasseur's wh'f.	64.33	3 24					
		H'd of flood	8.92	10.06	10.47	10.24	9.92
	7.75	Summit...	6.12	6.24	7.42	8.14	6.98
		Mean...	7.52	8.15	8.94	9.19	8.45
Batiscan Brunelle's wh'f.	72.08	3 48					
		H'd of flood	10.31	12.47	13.25	13.48	12.28
	7.40	Summit...	16.23	33.64	15.27	12.00	19.29
		Mean...	13.27	22.87	14.26	12.74	15.79
Champlain Gagnon's wharf	79.48	3 40					

As already stated in another part of this report, the fluvial tide wave partakes of the nature of waves of translation more and more as we proceed inland, and it is found that, in general, the law of propagation of such undulations holds good, viz. :—

$$V = \sqrt{g(H+h)} - U.$$

where  $V$  denotes the velocity of propagation,  $g$  the acceleration of gravity per second,  $H$  the depth of the estuary at low water,  $h$  the height of the wave above low water at the instant considered, and  $U$  the velocity due to the waters of the river proper at the same instant.

In regular waves of translation moving along in a horizontal channel of uniform depth and width, this relation holds good, as the above equation implies, for each one of its elementary slices or cross-sections of the channel, after the wave has assumed its definite sinusoidal form in the direction of the longitudinal axis of the said channel. But in a stream of ever-varying cross-section and declivity, the successive elementary slices must move onward at correspondingly varying speeds; those passing over the greater depths advancing more rapidly than those propagated through shallower water and overtaking them. It is for this reason that the fluvial undulations are continually getting steeper as they ascend in the estuaries of rivers, that is to say, the summit of the wave approaches more and more to the head of the flood, until finally, at the extreme upper limit of the maritime portion of the stream, the two coincide.

Owing to the continued foreshortening of the anterior and upper portion of each fluvial undulation, viz. : that contained between the summit and the head of the flood, this intumescence rises, in general, more and more above the level of the tideless stream, or diminishes in height above the said level, at a rate which is getting less and less according as the overlapping of elementary slices referred to is greater or less than would suffice to counterbalance the attenuation caused by friction, the rise of the river bed, &c.

Where this attenuation is taking place at a rapid rate, the slope of the locus of high tide levels has sometimes a contrary direction to that of the locus of low tide levels. On the St. Lawrence, above Quebec, the locus of the high tide levels slopes throughout seawardly, the same as that of the low tide levels, at all times and at all stages of the river during the open season, except on the reach between Québec and St. Nicholas, where the elevation of the wave summit is occasionally slightly (up to 0.05 ft.) greater at Quebec than at St. Nicholas, at high spring tides during the low water season. How far below Quebec this upward slope in the high water locus may continue, and at what precise point the tides generally reach their maximum amplitude, has, as yet, not been ascertained; but, as previously intimated, it is probably at no great distance below the ancient capital.

According to current measurements made by the Montreal Flood Commission at Lanoraie, in November, 1886, while the river was at an average elevation of 20.80 feet at Sorel, or 20.75 feet above the 0 of the Montreal Harbour Commissioners' gauge, and its mean depth 33.25 feet, the discharge of the St. Lawrence was 315,000 cubic feet per second, and when the water stands 0.75 feet lower, or 20.05 feet above datum at Sorel, the discharge may be assumed to be approximately equal to 315,000  $\left\{ 1 - \frac{3(38.25-32.50)}{2(33.25)} \right\}$

or say 304,000 cubic feet per second. I may remark, however, *en passant*, that the volume of 315,000 feet was slightly in excess of the actual quantity of surface or drainage water carried by the St. Lawrence per second at the time the current measurements were made, say, roughly, by from 500 to 1,000 cubic feet of water, that had accumulated in the estuary above Lanoraie, during the season of gaining tides immediately preceding new moon of 27th October, 1886, and that had to find its way out again during the succeeding series of losing tides.

Again, in a report made by the late Thos. Guerin, Esq., civil engineer, on what is known as the "Shearer" scheme of harbour improvements at Montreal, under date of 19th March, 1883, it is stated that on 6th June, 1882, when the water stood 23.50 ft.

over the sill of lock No. 1, foot of Lachine Canal, and 27.50 ft. above 0 Montreal Harbour Commissioner's Sorel gauge, the discharge was 431,733 cubic feet per second.

Now, during the time series of observations V., VI., VII. and VIII. were made, viz.: 4th May to 3rd June, 1888, the river remained at an average elevation of 29.90 ft. above datum at Verchères, or 27.60 at Sorel. We may, therefore, assume the mean discharge to have been at the rate of 432,000 cubic feet per second between the dates just mentioned.

Judging by the rate of propagation of the head of the flood and that of the summit of the fluvial wave deduced from the tidal observations made in 1887-88, as indicated above in tables Nos. VII. and VIII., it is evident that neither the former nor the latter advances regularly in accordance with the law indicated by the equation:

$$V = \sqrt{g(H+h)} \pm U.$$

Indeed the perturbations caused in the regular propagations of the fluvial waves, by winds, variations in the fresh water discharge, sudden contractions and enlargements of the waterway, etc., are occasionally so great that the head of the flood appears to advance faster than the summit of the same wave. This was notably the case during the low water season of 1887 between the Graving Dock, Chaudière and St. Nicholas stations, and during the high water seasons of 1888 between the Graving Dock and the River Chaudière, and between St. Jean des Chaillons and Batiscan. Notwithstanding that the mean amplitude is 13.58 ft. at low, and 13.19 ft. at high water between the Graving Dock and River Chaudière stations, the head of flood advances, in the former case over 11 miles faster per hour, and in the latter nearly 9 miles faster than the wave summit.

It has happened also in a few cases that the tide was high or low at two consecutive stations at nearly the same instant, which, taking for granted that the observations were made with great precision, seems to indicate infinitely great velocities of propagation.

In most instances the variations in the rates of propagation resulting from the increased outflow of water during series of losing tides, as compared to that which takes place during series of gaining tides, are apparently interwoven with other fluctuation of various kinds to such an extent as to prevent their being made out by themselves.

It is worthy of note, however, that notwithstanding great and numerous discrepancies between some of the observed and corresponding theoretical or computed times of high water, the fact of the difference between the mean of the observed and the mean of the computed priming or lagging of the tides being less than one minute at all the gauging stations from Quebec up to St. Jean des Chaillons, inclusive—according to the results entered in table No. VI.—goes to show that irregular variations in the very large fresh water discharge of the St. Lawrence and persistent high winds have, on the whole, little or no effect in checking or accelerating the regular propagation of the luni-solar wave generated in the Atlantic Ocean, up the estuary of the river as far as St. Jean des Chaillons.

At Batiscan and Champlain the average effect of the fresh water discharge and winds appear to have been to increase the lagging and priming of the tides from 4 to 7 minutes.

Again, according to the tabulated results just referred to (see table VI. of this report), the increased fresh water discharge of the high water season invariably diminishes the mean diurnal inequalities in the lagging or priming of the tides; thus, at the Graving Dock these mean observed inequalities amounted to 17 minutes in the fall of 1887, and only to 8 minutes in the spring of 1888.

Finally, I may call attention to the fact that while at the Graving Dock the mean uni-tidal interval is very nearly the same as the corresponding computed interval based on the Best times of high water, the discrepancies between the said intervals, due to the disturbances in the propagation of the oceanic wave caused by the fresh water, winds, etc., increase continuously as we proceed up stream, reaching on an average 4 to 5 minutes at Batiscan and Champlain.

In table No. IX. are entered the approximate average areas and depths of the St. Lawrence waterway, during the low water season, on the stretches between the tide

stations at mean tide, when it has an average amplitude corresponding to an astronomical coefficient of about 73, which areas and depths have been deduced from the soundings shown on the Admiralty charts and some river plans on record in the department—in connection with the corresponding values of the velocity  $U$  and the mean monthly amplitudes just referred to: also the mean depths  $H$  at low water, computed with the aid of the formula:  $V = 1 \sqrt{g(H+h)} + U$ , and those  $H$  based on the Admiralty soundings.

TABLE IX.

<p style="text-align: center;"><i>Low water—season of 1887.</i>  <i>Lunar month, 12th October to 10th November.</i>  <i>River surface at Vercheres at a mean elevation of 21.94 ft.</i></p>							
Section of River.	Mean Amplitude, $A$	Approximate area of water-way at mean tide level, according to soundings on Admiralty charts.	$U$ Velocity due to freshwater discharge at mean tide level, $= \frac{304,000}{A}$	$H + \frac{h}{2} = \frac{(V+U)^2}{g}$ Average depth of river at mean tide corresponding to mean rate of propagation of fluvial wave.	$H$ Average depth of river at low water, corresponding to mean velocity $V$ of propagation of fluvial wave.	Approximate average depth of estuary at mean tide, according to soundings on Admiralty charts.	$H$ Approximate average depth of estuary at low water, according to soundings on Admiralty charts.
	Feet.	Sq. feet.	Feet per second.	Feet.	Feet.	Feet.	Feet.
Graving Dock to River Chaudiere	13.82	225 000	1.35	62.89	55.96	61.0	54.2
Graving Dock to St. Nicholas	13.64	205 000	1.48	42.63	35.81	49.9	43.2
St. Nicholas to Platon	12.39	170 000	1.79	25.01	18.71	27.1	20.5
Platon to Grondines	9.63	130 000	2.34	18.38	13.56		
Grondines to St. Jean des Chailons	6.40	110 000	2.76	13.47	10.27		
St. Jean des Chailons to Batiscan	3.90	110 000	2.76	7.00	5.04		
Batiscan to Champlain	2.19	160 000	1.90	9.91	8.82		

As the soundings given on the Admiralty charts are 600 ft. apart, and the position of the plane to which they are referred could not be satisfactorily established, especially on the portion of the estuary west of Pointe Platon, the average depths which obtain at low tide, when the river water stands at an elevation of 21.94 ft. at Vercheres, were deduced directly from the said soundings, only in the cases of the three stretches of tide-way comprised between the Graving Dock, River Chaudiere, St. Nicholas and Pointe Platon stations.

On the portion of the estuary just mentioned, owing to the fact that the bottom of the thalweg lies here from 22 to 180 ft. below the mean level of the sea: 1st. Fluctuations in the discharge of the river proper, affect the water level correspondingly only from  $\frac{1}{10}$  to  $\frac{1}{6}$  as much as at Vercheres instead of from  $\frac{1}{10}$  to  $\frac{1}{6}$  above Pointe Platon. 2nd. A small error in fixing the position of the plane of reference adopted for the soundings shown by the Admiralty authorities, vitiates the resulting average depth much less than higher up stream; on the other hand the great contraction of the stream at the River Chaudiere must of necessity disturb the regular propagation of tidal undulations considerably. The average depths  $H$ , that have been determined by using the charts, agree, on the whole, as well as could be expected under the circumstances, with the values  $H$ , corresponding to the mean velocity of the fluvial wave, which have been computed with the aid of the formula  $H + \frac{h}{2} = \frac{(V+U)^2}{g}$ .

Above Pointe Platon the information afforded by the charts in this connection was found to be of too indefinite a nature, to permit of doing more than roughly estimate the probable area of the mean-tide waterway at the stage of the river last mentioned, for the purpose of arriving at an approximate value of the velocity due to the fresh water discharge. Notwithstanding the want of precision in the data derived from the charts, the results arrived at by using the formula just quoted give a good idea of the relative mean depths of the respective stretches of estuary, even on those between the tide-gauging stations established to the westward or above Pointe Platon. It is quite clear from the results given in table No. IX. that the portion of the stream where the resistance encountered by ascending tidal undulations is greatest, and where also the bed is most likely to be blocked up with ice, all things being equal in other respects, lies between St. Jean des Chaillons and Batiscan, and conversely the living force expended per mile by the tidal streams is, therefore, much greater on this stretch than on any other of the portion of the river under discussion, as also the sinking of the general level of the estuary that must ensue from the improvement of the ship channel by deepening, widening or straightening. On account, however, of the vast proportions of the St. Lawrence, any permanent lowering of its low water level due to this latter cause will always prove to be small in comparison to the depth in the thalweg, while at high water the river level will be slightly elevated in a corresponding manner.

An attempt might be made at estimating the probable effect produced on the mean river level by improvements carried out in the ship channel on the upper portion of the St. Lawrence estuary, after the projected accurate hydrographic surveys between Quebec and Cap à la Roche, etc., shall have been completed, when the prospect of reaching a reliable conclusion will be far better than at present.

On the open sea there exists a definite relation between the height  $h$  of the tide wave and the depth  $H$  of the water; the height  $h$  varying from place to place, approximately, in the inverse ratio of the square root of the depth  $H$ , viz., as  $\frac{1}{\sqrt{H}}$ .

This relation does not necessarily continue to obtain during the propagation of the oceanic wave inland up the estuary of a river. The height reached by the fluvial wave depends, in a large measure, on the greater or less elevation of the oceanic wave which generates it opposite the mouth of the estuary.

The fluvial intumescence is the result of the united actions of an undulatory motion and the pouring in of sea water which takes place continuously during the flood, on account of the rise of the waters of the sea, due to the former cause, being more rapid than that of the waters of the stream.

The principal effects produced by all oscillatory motions are: 1st. The elevation of a portion of the waters in which they are produced above their mean level, 2nd. The simultaneous depression of adjoining portions below the said level. On the open sea the quantity of water elevated is sensibly equal to that depressed below the mean level, during the propagation of pendular waves of oscillation. (See diagram A.)

On account of the mixed or composite nature of fluvial waves, the ratio of the height to which the tidal intumescence becomes raised above the level of the tideless stream to the depression which takes place in the said level, is continually increasing as we proceed inward, and in the upper reaches of long estuaries, the tide water always remains at a higher elevation than the level of the tideless stream corresponding to the same fresh water discharge, whether at high or low tide.

Considering that the fresh water carried by the stream supplies a portion of the liquid required to satisfy the conditions of the undulatory motion, it is clear that while the discharge remains uniform the trough of the fluvial wave will be less depressed in reference to the level of the tideless stream, or more elevated per unit of increase in the amplitude of the oceanic wave, as these waves diminish in importance.

On the other hand, the rise of the summit of the fluvial wave per foot of increase in the amplitude of the oceanic wave must become notably greater, as the theoretical or astronomical importance or coefficient of amplitude diminishes. For, in any waterway where the flow takes place by virtue of the descent of the liquid particles from a higher

to a lower level, the velocity of the current varies, in general, approximately as the head of the square root lost, or fall, and if the area of the cross-section of the waterway remains sensibly constant, the volume of water carried through it also varies in the same ratio. In the case of fluvial waves, the volume of water poured into an estuary from the sea while the flood lasts at its mouth, is forced up to greater or less heights above the level of the tideless stream: according to the degree of convergence of the banks, the slope of the bed, the loss of hydraulic head caused by friction, sudden enlargements and contractions, etc.: the total work performed by the inflowing stream being invariably equal to the energy supplied by the sea.

In the upper part of a long estuary, where the effect of the direct propagation of the pendular oscillation generated on the open ocean is small, the relations between the theoretical amplitude  $A$  of the said wave, and the height  $h$  of the fluvial intumescence above the level of the tideless stream, may be nearly represented by some such equation as  $h = nA$ , which is that of the common proportion.

From the remarks just made it appears that both the feet of the high and low water levels, as per diagrams Nos. XVI to XXII, must necessarily be concave on their lower sides: the degree of curvature of the low water curves is, however, in all probability quite small: and any computations as to a very short distance of the axis of ordinates where a certain small number is, at any rate too small, to be determined with any degree of certainty, between the ordinates corresponding to the coefficients of the greatest and least tides, as Nos. VII, VIII and IX.

It may be added, that the low water lines of all rivers having theoretical coefficients not less than 0.8, if this was less, the water line in the prolongation of the high water curve represents in diagrams XVI to XXII, the general geometrical locus of the low water curves, as it is asserted when these are plotted after being corrected for variations in the flood water discharge, in the case of the said theoretical or astronomical coefficients of the impulsion, as have been treated—the intersection  $I$  of the low water line with the axis of ordinates will show the elevation of the tideless stream level, which is greater than the assumption, as shown in the nature of the case above.

The above curves of the cross-section at the gauging station for the standard low water level, are taken on a scale of 100 feet in 1 inch, and 27 3/4 feet at Lock No. 1, Quebec, which corresponds to a rise of 100 feet in the lower side of this lock, are approximately as follows:—No. X.

The above curves are drawn on the assumption of the total rise to Quebec and New Brunswick by the St. Lawrence River, of 100 feet, which height is accumulated in the St. Lawrence River, and is taken into the low water lines of the higher and lower rivers, as shown in the accompanying respectively to coefficients Nos. XI and XII.

Total distance along axis of River.	Intermediate distance.	Gauging Stations.	Elevation of tideless stream in feet above datum with 16 feet depth on sill, lock No. 1, Lachine Canal.	Intermediate falls in feet.	Total fall in feet to Graving Dock.	Intermediate hydraulic inclinations in feet per mile.	Total hydraulic inclinations to Graving Dock, feet per mile.	Average elevation of low water level of mean tides of minimum amplitude corresponding to coefficient 30 with 16 feet water over sill, old lock No. 1, Lachine Canal, feet above datum.	Probable average depth of tide-water accumulated in (+) or withdrawn from (-) tideless estuary above or below low water line of tides of minimum amplitude in feet.	Average elevation of low water level of spring tides of maximum amplitude corresponding to coefficient 118 with 16 feet water over sill, old lock No. 1, Lachine Canal, ft. above datum.	Probable average depth of tide-water accumulated in (+) or withdrawn from (-) tideless stream above or below low water line of tides of maximum amplitude in feet.
0		Graving Dock.....	1.15	0.30	0.30	0.0222	0.0222	+ 0.628	- 0.522	- 0.893	- 2.048
13.5	13.5	St. Nicholas (Baker's wharf).....	1.45	0.85	0.30	0.0222	0.0222	+ 1.104	- 0.346	+ 0.155	- 1.295
37.5	24.0	Platon (Hon. G. H. Joly de Lotbinière's wharf).....	2.30	0.85	1.15	0.0354	0.0307	+ 2.519	+ 0.219	+ 3.519	+ 1.219
48.8	11.3	Grondines (Public wharf).....	6.55	4.25	5.60	0.3761	0.1148	+ 6.888	+ 0.338	+ 8.485	+ 1.936
54.0	5.2	St. Jean des Chaillons (Levasseur's wharf).....	8.70	2.15	7.55	0.4135	0.1388	+ 8.778	+ 0.078	+ 10.600	+ 1.900
61.8	7.8	Batisseau (Brunelle's wharf).....	12.55	3.85	11.40	0.4936	0.1845	+ 12.887	+ 0.337	+ 14.311	+ 1.761
69.0	7.2	Champlain (Gagnon's wharf).....	13.70	1.20	12.55	0.1666	0.1819	+ 13.984	+ 0.284	+ 15.376	+ 1.676
80.8	11.8	Three Rivers (Doucet's landing, G.T.R. wharf).....	16.06	2.25	14.91	0.1907	0.1845	+ 16.310	+ 0.250	+ 17.640	+ 1.580
87.3	6.5	Port St. Francis (R. & O. Nav. Co.'s wharf).....	16.16	0.10	15.91	0.0155	0.1720	+ 16.380	+ 0.230	+ 17.660	+ 1.500
118.0	30.7	Sorel (McCarthy's wharf).....	18.85	2.75	17.70	0.0886	0.1500	+ 19.000	+ 0.150	+ 20.280	+ 1.380
133.0	15.0	Contrecoeur (Public wharf).....	19.85	1.00	18.70	0.0467	0.1406	+ 19.970	+ 0.120	+ 20.990	+ 1.140
141.0	8.0	Verchères (Public wharf).....	21.42	1.57	20.27	0.1963	0.1438	+ 21.500	+ 0.080	+ 22.250	+ 0.830
160.0	19.0	Longueuil (Government wharf).....	25.18	3.76	23.03	0.1979	0.1502	+ 25.200	+ 0.020	+ 25.900	+ 0.420
163.5	3.5	Montreal (foot of Lachine Canal).....	27.54	2.38	23.41	0.0800	0.1615	+ 27.540	+ 0.000	+ 27.740	+ 0.200

## DETERMINATION OF EXTREME AND OTHER CHARACTERISTIC HIGH AND LOW WATER LEVELS AT THE VARIOUS TIDE AND RIVER GAUGING STATIONS, ETC., BETWEEN QUEBEC AND MONTREAL.

We may, for the present purpose, assume that the comparatively small volume of water supplied by the affluents which enter the great St. Lawrence, below its junction with the north branch of the Ottawa at Bout de l'Île, does not affect the water level of the river and estuary below, say Verchères, sufficiently at any time of the year to be worth taking into consideration.

Even the quantity of water which flows into the St. Lawrence from this branch of its greatest tributary, is so small, in comparison to the immense volume which passes down the principal stream—275,000 to over 400,000 cubic feet per second—that it cannot materially affect the level of the latter.

At any rate, no error of consequence can result from the supposition: that changes of level are generally taking place simultaneously in the two streams in the same direction, and that within the limits of a few feet, these variations bear to each other a nearly uniform or constant ratio. Thus, we are safe in assuming that not only extreme high and low; but also common high and low water occur, under ordinary circumstances, simultaneously at the foot of the Lachine Canal, Montreal, and at the gauging station which was intentionally established at a point a short distance below the influx of the northern branch of the Ottawa River into the St. Lawrence, viz., on the public wharf at the village of Verchères. It is believed that gaugings made at Verchères afford, on the whole, a better indication of the variations in the fresh water discharge through the St. Lawrence estuary, than gaugings made at the stations situated immediately above or below the said locality, because it is the highest point at which any small change of level that might be caused by the influx of the Ottawa at Bout de l'Île is felt, while at the same time the influence of the tides can affect the height of the river only to an insignificant extent, in comparison to the fluctuations which may be produced by variations in the large volume of fresh water carried by the river.

### EXTREME HIGH RIVER LEVEL.

The highest water observed since 1852, at Montreal, by the lock-masters of lock No. 1, at the foot of the Lachine Canal, after the St. Lawrence was clear of ice, that is to say, the greatest permanent swelling of the river caused by the waters from the Ottawa valley, or the northern waters, as they are termed, occurred on the 15th, 16th and 17th of May, 1876, when the depth on the lower sill of the said lock was, according to the water registers, 28 ft. 8 in. = 28.67 feet, each day at noon.

This depth of 28.67 feet on the sill of the old lock No. 1, corresponds to a water surface 40.21 feet above datum, if measured at the west side of the lock, and to 40.24 feet, if measured on its eastern side. The depth on the sill, registered May 15th and 16th, 1876, at lock No. 5, at the head of the Lachine Canal, viz., 17 ft. 3 in., is also the greatest on record since 1852; this depth of 17 ft. 3 in. corresponds to a water level 79.96 feet above datum in the upper entrance to the canal, immediately above the guard lock (No. 5). The mean depth registered at lock No. 1, during the high water season of 1888, between 19th and 26th May, viz., during the week when series of observations No. VII. was made at Verchères, is 24 ft. 4½ in. = 24.39 feet, while the mean of the water level observed and registered at Verchères, during the same interval, is 31.50 feet above datum; the depths on the lock sill having varied between 24 ft. 8 in. and 24 ft. 0 in., and the elevation of the river at Verchères between 31.80 and 31.10. By taking the interval between 12th and 19th May, which corresponds to that of series of observations No. IV., when the St. Lawrence rose from 22 ft. 1 in. to 24 ft. 6 in. on the sill of lock No. 1, in connection with the interval between 27th May and 3rd June, which corresponds to that of series No. VIII., when the river fell from 24 ft. 6 in. to 22 ft. 8 in. it is found that a mean depth of 23 ft. 4½ in. = 23.39 feet, corresponds to a surface 30.57 feet above datum at Verchères.

It would appear from the statement just made that a rise of 1 foot in the river at lock No. 1, from 23.39 to 24.39 over the sill, corresponds to a rise of the water at Verchères from elevation 30.57 ft. to elevation 31.50 ft., viz. : only 0.93 ft.

If, however, we take into consideration the aggregate rise which took place under special favourable conditions hereinafter described, in each one of the said localities from 3rd November, 1887, to 20th May, 1888, we find that a change of 1 foot at lock No. 1 corresponds, on a average, to one of  $\frac{10.10}{8.41} = 1.2$  ft. at Verchères. I believe this coefficient (1.2) to be more nearly correct than 0.93 which may be materially vitiated owing

to small tidal perturbations, local variations in the fresh water supply, etc.

Assuming, therefore, when the flow is permanent or nearly so, that the St. Lawrence rises at Verchères, 1.2 ft. for every foot of rise of the water at the lower end of the Lachine Canal between levels 24.39 ft. and 28.67 ft. above the sill of lock No. 1, it is found that this latter depth which denotes the highest water on record at Montreal during the season of navigation, corresponds to a river level  $31.50 + (4.28 + 1.2) = 36.636$ , or say 36.60 ft. above datum at Verchères.

According, however, to the water register kept by Mr. Levi Larue, superintendent of the St. Ours Lock on the Richelieu River, who is in every sense a painstaking and reliable public officer, the water of the said river below his lock stood on the 15th and 16th of May, 1876,  $22' 2\frac{1}{2}"$  over the lower mud sill and hence was  $12.657 + 22.21 = 34.867$  ft. above datum. Moreover, the fall of the Richelieu from the St. Ours Lock to the St. Lawrence at Sorel was 0.82 ft., according to actual measurements made in the spring of 1885, when the water above the lock was not very much higher than in 1876. Placing therefore this fall at 0.80, we find that at Sorel the highest water known to occur during the season of navigation, viz., that of 15th and 16th May, 1876, was  $34.867$

$0.80 = 34.067$  ft. above datum, and if we add to this height 2.25 ft. for the probable rise, Sorel to Verchères, the elevation of extreme high water at this place is found to be 36.317 or 36.32, which is all probably the more correct figure.

#### LOWEST NORMAL RIVER LEVEL.

I understand that since 1880, the Montreal Harbour Commissioners have adopted the low water level corresponding to a depth of 16.5 ft. on the sill of old lock 1, as a plane of reference for their soundings in their harbour and its vicinity; but in my opinion the department should adopt as a basis for all further dredging operations between Quebec and Montreal, a water level corresponding to at most 16.0 ft. depth on the said sill. For, during the last nine or ten years the river fell several times to this level, and lower still, notably in November, 1879, and September, 1881, when it remained below the said level continuously for two weeks in each month; moreover, on all Canadian rivers in general, the low water level tends to fall more and more as the country drained by them is being cleared of forests.

#### EXTREME LOW RIVER LEVEL.

The lowest water on record at Montreal was observed on the 8th and 9th of November, 1879, viz., two and three days after the moon had entered her last quarter, and on Thursday, 6th October, 1881, viz.,  $5\frac{1}{2}$  days after she had passed into the last quarter, the depth on the sill of old lock No. 1 being in both cases only  $15' 5" = 15.42$  feet. On the 8th and 9th November, 1879, the water stood  $9' 6"$  over the sill of lock No. 5, at the head of the Lachine Canal. The weather was fine at the time and the wind westerly; in perfectly calm weather the depth on the lock sill last mentioned would probably not have exceeded  $9' 4"$ , which may be considered to indicate the lowest normal water of the St. Lawrence on record at Lachine. It is true the river fell to  $9' 1"$  in November 1868, and to  $8' 10"$  in November, 1871; but these depths show exceptional depressions of Lake St. Louis, caused by high easterly winds.

The easterly wind which was blowing during the greater part of the time between the 5th and 11th November, 1879, no doubt also kept the river, for some distance to

the eastward of Montreal, slightly lower than it would have stood if the weather had been perfectly calm, or if the wind had come from another direction ; but probably only to a small extent, for I was at the time engaged on a survey at Longueuil, on the beach along the south shore of the St. Lawrence, and, to my recollection, the breeze was never very strong, and sometimes barely perceptible. The principal causes of the unusual sinking of the water level were the great drought which prevailed during the latter part of the fall of 1879, and the diminished amplitudes of the tides.

On the 6th October, 1881, the depth on the sill of lock No. 5 was 9' 7", and at Sorel the elevation of the St. Lawrence was according to the measurements made at the foot of the St. Ours lock : (19·08 ft. — 0·33 ft.) = 18·75 ft. ; but the Montreal Harbour Commissioners' Sorel gauge register shows the river to have stood at a height of 19·05 ft. above datum, wind westerly. The gaugings were, in all probability, made at different hours of the day at Sorel and St. Ours.

By taking the mean of the depths of the water on the sill of lock No. 1, which obtained between 12th October and 10th November, 1887, a complete lunar month, and also the mean of the elevations of the river as determined from the gaugings made at Verchères during this lunar month, it is found that a depth of 16 ft. 5 in. = 16·42 ft. on the sill corresponds, in calm weather, to a water surface of 21·94 ft. above datum at Verchères. During the said lunar month the greatest depth recorded at lock No. 1 was 16' 9", and the least, 16' 0" ; while at Verchères the highest water observed stood 22·673 ft. over datum, and the lowest 21·573 ft.

During the space of time covered by series of observations Nos. I and IV, viz. : 19th to 25th October, and 3rd and 19th November, 1887, the average water levels between Montreal and Verchères, corresponding to the first interval, differed : at Verchères by 0·46 ft. : at Longueuil by 0·381 ft., and at the foot of the Lachine Canal: Montreal, by 0·42 ft., from the respective average levels corresponding to the second interval. If we allow that the same rates of variation obtain between the limits of 16' 6" and 15' 5" above the lock sill, as between the limits last stated, we find that :

1st. The Montreal Harbour Commissioners' ordinary low water, with 16·5 ft. depth on the sill of lock No. 1, corresponds, on an average, taking the tidal oscillations of a complete lunar month into account, to a water level :  $21·94 + \frac{(16·50 - 16·42) \times 46}{42}$   
 = 22·03 ft., or say 22·0 ft. above datum at Verchères.

2nd. The low water now proposed for adoption by this department, with 16 ft. depth on the sill, to an average monthly level of  $21·94 - \frac{(16·42 - 16·00) \times 46}{42} = 21·48$  ft., or say 21·50 at Verchères.

3rd. The extreme low water observed in November, 1879, with 15' 5" = 15·42 ft. on the sill, to a corresponding mean monthly level of  $21·94 - \frac{(16·42 - 15·42) \times 46}{42} = 20·85$  ft. above datum at Verchères.

### INFLUENCE OF TIDES ON WATER LEVELS OF ST. LAWRENCE ABOVE THREE RIVERS.

Thus far we have considered exclusively the fresh water fluctuations, it is now in order to investigate a little more closely than was hereinbefore attempted, the effects of the tides on the level of the water at each gauging station during various stages of the river.

Strictly speaking, the spring tides now and then influence the water level to the extent of usually one or two or three inches, even as far up stream as the foot of St. Mary's current, or St. Helen's Island, opposite the city of Montreal, and I have been informed by Mr. Louis Duval, an old respectable, observant citizen of Longueuil,

who has rendered valuable services of various kinds in connection with several river and harbour works which have been carried out during his lifetime in the vicinity of this town, including the new Government wharf, that some mornings he noticed, that the water had risen during the previous night as much as from 12 to 18 inches, as the result of the combined effects of high spring tides accompanied by stiff easterly winds. He says, moreover, that he also saw the water fall nearly as much, viz., some 12 inches in one night, about the time of quadrature of the moon, when strong westerly winds prevailed.

From Lake St. Peter up to Montreal the water level may be considered as being continually in a transitory state of equilibrium, similar to that which obtains on the lower or maritime portion of the St. Lawrence. On the stretch referred to, the river is either almost continuously raised or prevented from falling as rapidly as it otherwise would, by surplus tide water brought up by the waves of translation which are formed during series of gaining tides, or else it (the river) is lowered or prevented from rising as fast as it otherwise would, during series of losing tides, owing to some of the water being incorporated into outgoing, or return waves.

It may be said, however, that there is this difference between the two portions of the St. Lawrence in question, to wit: while, say from Port St. Francis, at the outlet of Lake St. Peter eastward, two distinct undulations are easily discernible every lunar day, and high and low water recur at sensibly regular intervals when the undulations are not too much disturbed by winds, etc.: from Port St. Francis to Montreal, the effect of each individual tide wave is, as a rule, too small to be plainly made out, except at high spring tides.

At Yamaska, Sorel and Contrecoeur the effect produced on the water level by each individual tide, is distinctly noticeable during from two to three days before and after the tides reach their maximum amplitudes, especially during the low water season. I have already shown in the report I addressed you under date of 26th August, 1885, on the levelling operations carried out along the Richelieu, that one series of gaining tides may produce a rise of 1.0 foot or more, and a series of losing tides a fall of a foot in the water level at Sorel; the extent of the rise or fall depends, of course, primarily, on the importance of the astronomical tides which produce it; but also, in a great measure, on the winds which prevail at the time, and on the diurnal inequalities. Indeed, from Lake St. Peter to Montreal, changes of level caused by tidal fluctuations, winds and variations in the fresh water discharge, not to speak of the waves raised by steamships and tugs during the season of navigation, are so much interwoven, that it is not an easy matter, not to say impossible, to disassociate one kind of variations from another, and there appears to be no alternative but to consider them as a whole.

It will be seen from an inspection of the water lines shown on diagrams Nos. XI. and XV. at their correct elevations above datum, according to simultaneous observations made in 1887 and 1888 at the low and high water seasons, that at Three Rivers, Port St. Francis, Sorel, Contrecoeur, Verchères and Longueuil the mean tide levels of the river vary on the whole in a corresponding manner, and when the flow of river water is nearly permanent, the ratio between the rise or fall at one place to the corresponding variation at another east or west of it, remains sensibly constant within a foot or two and more at any stage of the river whether high or low.

With a nearly uniform discharge of river water, the fall from Longueuil to any point above Sorel increases when the tides are losing, and decreases when the latter are gaining in importance, so that the declivity reaches its maximum value and the current is strongest, about the time of neaps, and the declivity is smallest and the current weakest about the time of spring tides. The main reason of this is, that more tide water is stored in the estuary at springs than at neaps; moreover, the fluctuations due to this cause are greater on Lake St. Peter than on adjoining stretches of river. As the declivity of an ordinary fresh water stream always increases when it is in a rising condition, the said slope must therefore increase on the St. Lawrence estuary as on all tideways in general, much more rapidly under such circumstances when the tides

are losing than when they are gaining and *vice versa*. It cannot be said, however, that the slope of the river surface between Lake St. Peter and Longueuil, which obtains at the time of extreme high water in May or June, is, on the whole, very different from the declivity at extreme low water in October or November, notwithstanding that the difference in the height of the water at these two stages is from 9 to 14 feet or more.

On the 20th of May, 1888, after the flow of the river had been as nearly permanent as the circumstances of the case admit of, for three or four days during which the summits of the tidal undulations had varied but little in elevation, as the waves entered Lake St. Peter, and their coefficients of amplitude varied only between 51 and 46—the water stood 35.50 ft. above datum at Longueuil: being exactly 10.10 ft. higher than on 3rd November, 1887, when similar conditions obtained not only as regards uniformity in the heights of the summits and the theoretical amplitudes of the tide waves of the three or four preceding days: but also as regards the comparative permanency of the flow during the same time.

Again, the elevation of the water at Sorel on the 20th May, 1888, was 29.55 ft. and on the 3rd November, 1887, 19.18 ft. above datum, hence the fall or slope of the river between Longueuil and Sorel was only 5.25 ft. at extreme high water in May, 1888, while it was 6.20 ft. at low water in November, 1887, that is to say the river rose at Sorel 0.25 ft. more during the high water season than at Longueuil, viz., 10.35 ft. instead of only 10.10 ft.

The elevations of the river at the five gauging stations established between La Prairie and Sorel, and also at locks Nos. 5 and 1, Lachine Canal, viz.: on 3rd November, 1887, and 20th May, 1888, together with the falls between the consecutive places, the total falls from Longueuil, etc., were found to be as shown in table XI. hereunder: the said river levels may be considered as representing approximately the mean semi-monthly elevations of the water in all instances where diminutive semi-diurnal variations caused by the tides are discernible, which is more especially the case at high springs.

TABLE XI

Name of Gauging Station.	At Low Water, 3rd Nov. 1887.			At High Water, 20th May, 1888.			Total rise of water at each place from 3rd Nov., 1887, to 20th May, 1888.
	Elevation of water on the above datum.	Fall between each two consecutive stations.	Total fall from Longueuil.	Elevation of water on the above datum.	Fall between each two consecutive stations.	Total fall from Longueuil.	
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
Lock No. 5, lower Lachine Canal.	29.74	4.96	4.96	34.46	35.72	41.96	4.67
La Prairie.	30.76	1.02	6.00	34.94	4.90	5.30	4.28
Lock No. 1, lower Lachine Canal.	31.78	1.02	7.02	35.74	0.84	6.14	8.41
Longueuil.	35.50	3.76	10.78	36.40	3.70	9.84	10.10
Verdun.	35.70	0.20	11.00	36.40	0.00	9.84	10.10
Châteauguay.	35.70	0.00	11.00	36.40	0.00	9.84	10.50
Sorel.	35.43	0.00	11.00	36.40	0.00	9.84	10.35

N.B. The elevations at locks Nos. 5 and 1, Lachine Canal, are based on the elevations of water on the sills of the locks, and on the depths on the sills given

by them being respectively 10·1 ft. and 16·2 ft. for 3rd November, 1887, and 14·9 ft. and 24·7 ft. for 20th May, following.

These results go to show that Lake St. Peter with adjoining river stretches up to past Sorel and down to past Three Rivers, forms a sheet of water of such vast extent and so flat that its surface has to rise some  $5\frac{1}{2}$  feet and the whole river up to Longueuil with it, in order that the increased volume of water which comes down the St. Lawrence in the spring may make its way to the Gulf—otherwise, on account of the increase in the friction head generated when the stream is in a swollen state, the total declivity from Longueuil to Sorel would have been much greater, instead of being smaller at the high than at the low water season.

It has been shown that at Quebec the amplitudes of the tides are no longer directly proportional to the astronomical coefficients, in other words, that the unit of height is here a variable quantity, which generally turns out to be greater when based on a tide with a coefficient less than unity, than when based on a tide having a coefficient greater than 1. It is also clearly apparent from the tidal diagrams that as we ascend the estuary, and as the river passes to lower and lower stages this divergence accents itself more and more. Hence, on the contrary, by moving in a north-easterly, or downstream direction along the estuary below Quebec, we must approach more and more towards a point of the Gulf or Atlantic coast, where the ratio between each theoretical and its corresponding actual coefficient of amplitude is as nearly uniform as the complex nature of the case permits.

Whether the importance of the tides varies on the eastern coast of North America absolutely according to the same laws as it does on the coast of France, for which in particular the tidal coefficient given in "L'Annuaire des Marées" are calculated, and the western coast of Europe generally, I am not prepared to affirm; but the resemblance of the main features of the high and low water curves based on the theoretical amplitudes shown in connection with the loci of the high and low water levels corrected for diurnal inequalities, of the eight continuous series of gaining and losing tides covering two complete lunar months, which were observed very closely October 12th to 10th November, 1887, and 5th May to 3rd June, 1888—is such as to warrant us in adopting as the best basis available for the determination of extreme and other typical high and low tide levels, the hypothesis that the tide waves on both sides of the Atlantic truly are contemporaneous and have the same relative importance. I have thought it advisable to establish first such typical mean high and low water levels of the estuary as are likely to obtain in normal conditions of weather, including atmospheric pressure: 1st at the time of spring tides having the greatest possible theoretical mean amplitude, viz.: that which corresponds to a coefficient of 118; 2nd at the time of neaps of least importance, the coefficient of which is about 30; leaving the effects of diurnal inequalities and of persistent high winds, to be dealt with separately.

During series No. I. of gaining tides, observed 12th to 18th October, 1887, the water level was raised about 0·75 feet at Sorel and only 0·45 feet at Longueuil. If we assume that the rise which took place at Longueuil was exclusively due to an increase in the fresh water discharge from above, the effect of series No. I. of gaining tides on Lake St. Peter is found to be a rise in the water level of (0·75 - 0·45 feet) = 0·30 feet. In this series of tides (No. I.) the astronomical coefficients varied as already stated, between 39 and 117, with an average value of 84·84.

During series of losing tides No. II., observed 18th to 25th October, 1887, and which also correspond to astronomical tides with coefficients decreasing from 117 to 39, but having an average value of only 77, the water fell at Sorel about 0·90 ft. and at Longueuil only about 0·30 ft.; probable effect of this series of tides in lowering the water

level, say, 0·50 ft. Hence we may put approximately:  $\frac{0\cdot30 + 0\cdot50}{2} = 0\cdot40$  ft. for mean change of level produced by series Nos. I. and II. of 13 gaining and 13 losing tides the average importance of which may be represented by an astronomical coefficient =  $\frac{84\cdot84 + 77\cdot0}{2} = 80\cdot92$ , or say 81.

As a gradual change of  $(117 - 39) = 78$  in the theoretical coefficient of semi-amplitude of series of tides having a mean coefficient of importance = 81, may be considered to affect the water level around Sorel to the extent of nearly 0.40 ft. on an average, we may assume that with a series of tides of minimum importance, the coefficients of which may vary, say between 93 and 30, with a mean value of 65 or less, the water level would probably, at the same stage of the river, be further depressed from the level corresponding to the 39 tide, by about  $\frac{39 \cdot 30 \times 0 \cdot 40}{78} = 0 \cdot 046$  on an average, or say 0.05 ft.

Now, at the beginning of series of tides No. I. and at the end of series No. II., when the astronomical tidal coefficient was 39, the river stood at Verchères at an average height of 21.95 nearly, and the mean elevation of the water at Sorel was 19.50; hence, with the minimum series of tides just described, the water at Sorel would have stood  $(19.50 - 0.05) = 19.45$  ft. above datum. Moreover, at extreme low water, 20.85 ft. above datum at Verchères, the said minimum low water level would be  $(19.45 - 21.95 - 20.85) = 18.35$  ft. above datum, and at the standard low water stage, 21.50 ft. above datum at Verchères, to which it is suggested all the soundings should be referred, the same minimum tide level would, at Sorel, be  $19.45 - (21.95 - 21.50) = 19.00$  ft. above datum.

As a matter of fact, the lowest water recorded in the Montreal Harbour Commissioners' Sorel water register for 1879 is 18 ft. 8 in. above the 0 at the lower end of their gauge, viz.: on the 10th of November. The elevation of this 0 was found, in 1885, to be about 0.03 ft., hence the height of 18 ft. 8 in. = 18.65 ft. indicates a water level 18.71 ft. above datum, viz.: 0.36 ft. higher than the computed extreme low water level; but then it must be borne in mind that the serial tidal amplitude, although small, was probably not an absolute minimum at the time in question. Again, considering that the height of the river was observed only once in 24 hours, the elevation of the water may have been and probably was, lower than 18.71 ft. either on the 9th or 10th of November. Moreover, the gauge board used was subdivided only into 3-inch spaces, and water levels could, consequently, not be read with precision; the gauge board may, at the time, also have been slightly too low in the water, in reference to the bench marks made on land, on account of the subsidence of the cribwork pier to which it was spiked or on account of having been shoved out of its proper place by a passing vessel and not put back again.

We can arrive at the extreme and standard low water and the extreme high water elevations at Laprairie, Longueuil and Contrecoeur, with sufficient accuracy for practical purposes, by supposing, where more definite information is wanting, that the average rate of increase or decrease in the declivity between two consecutive places, per foot of rise or fall in the water at one or the other of these points, which obtained while the river rose from the level of 3rd November, 1887, to that of 20th May, 1888—or between any two other known stages of the river that might be better suited for the determination of the particular level sought—also hold good during the further lowering of the river down to standard and extreme low water and the further rising of the same up to extreme high water.

Table XII, which here follows, shows the extreme and standard low and extreme high water levels at the gauging stations from Lock No. 5 to Sorel, which have been determined in the manner here described.

TABLE XII.

Name of Gauging Station.	Elevation of highest known water during season of navigation.	Elevation of lowest known water during season of navigation.	Elevation of standard low water with 16 feet depth on sill lock 1, Lachine Canal.	Notes.
	Feet above datum.	Feet above datum.	Feet above datum.	
Lock No-5, head of Lachine Canal .....	79·96	72·04	72·04	9' 4" + 62·71 ft. = 72·04 ft. in Nov., 1879. 17' 3" + 62·71 ft. = 79·96 ft. in May, 1879. Water surface at elevation 74·38 at lock 5 corresponds to mean summer level with 19' 0 ft. depth on sill lock 1, 24·95 ft. above datum at Verchères, and 22·50 at Sorel.
Laprairie public wharf. . . . .	43·23	38·39	38·40	28' 8" + 11' 54" = 40·22 ft. in May, 1876. 15' 5" + 11' 54" = 26·96 ft. in Nov., 1879.
Lock No. 1, foot of Lachine Canal .....	40·22	26·96	27·54	17' 6" on sill old lock No. 1 corresponds to river surface 23·25 ft. nearly above datum at Verchères.
Longueuil Government wharf .....	40·02	24·55	25·20	22' 2½" depth lower sill St. Ours lock, May 6, 1876, plus 12' 657 minus 0·80 ft. fall to Sorel = 34·07 ft. Elevation 0 Mont. Hbr. Crs'. gauge at Sorel = + 0·05 ft.
Verchères public wharf . . . . .	36·32	20·85	21·50	
Contrecoeur public wharf. . . . .	35·17	19·25	19·90	
Sorel, McCarthy's wharf. . . . .	34·07	18·35	19·00	

As already remarked in connection with table of water levels XI. for 3rd November, 1887, and 20th May, 1888, the elevations of extreme high water here given for the stations between Longueuil and Sorel, where not only aggregate but also single effects of high springs are to some extent discernible, indicate respectively more nearly the position of the mean high tide levels of such springs above datum, than the heights of the corresponding maximum high tide levels which would be arrived at, if diurnal and weekly tidal inequalities and small local variations were also taken into account.

I may here bring to your notice a singular change in the general slope assumed by the river surface, which has been found to obtain during the low water season, along the south shore between Contrecoeur village and a point some 2½ miles west of the wharf at this place, and about ¼ mile above Jos. Dansereau's stone house which stands at the junction of the post road as originally constructed, with a new portion of road opened on higher ground to prevent further damage by spring floods.

According to the series of simultaneous observations of the water level made between the points mentioned on the 29th of August, 1887, when the water stood on an average 23·10 feet above datum at Verchères and 17·5 feet over sill of lock No. 1 at Montreal, the fall on the said stretch was from elevation 22·58 ft. to elevation 21·50 ft. above datum, viz: at the rate of 0·4320 per mile, while the general slope of the river for 5 miles above is  $\frac{0·44 \text{ ft.}}{5} = 0·088 \text{ ft.}$ , and for 5 miles below only  $\frac{0·35 \text{ ft.}}{5} = 0·07 \text{ ft. per mile.}$

The slope in question was also determined and a similar result arrived at, by using data derived from some accurate gaugings made at the Verchères and Contrecoeur wharves during the latter part of August, 1888, in connection with the corresponding depths on the lower sills of lock No. 1, Lachine canal and the St. Ours lock, which are given in the lock-masters' registers; at the end of August, 1888, the elevation of the

river surface differed but four or five inches from the height it had reached the previous year on corresponding days in August.

Being apprehensive that, despite the numerous precautions taken to secure correct results, both as regards levelling and gauging operations, an error had been committed in some unaccountable way, for the field notes had all been closely examined and the computations checked and rechecked in vain, the continuous line of simultaneous double levellings run all along the south shore of the St. Lawrence was re-levelled in June, 1887.

C. C. from B.  $\ominus$  M. in Jos. Dansereau's house to B.  $\ominus$  M. on the Contrecoeur church, and another CXXX CXXIX

series of simultaneous observations of the water level made on 21st June, 1889, when the river was at a height of 26.50 feet deep over sill of lock No. 1 instead of 21.50 feet and 17.30 feet respectively on the 29th August, 1887. The result of this work was to prove the accuracy of the original levelling operations in every particular: but the declivity was now found to be practically uniform above and below Contrecoeur.

I have come to the conclusion, that the sudden drop in the river surface at low water, is caused by the long string of narrow islands and intervening shoals lying between the main or ship channel and the south shore, from a point say  $2\frac{1}{2}$  miles above Contrecoeur village, for some 6 miles in length towards Sorel. These islands together with the intervening high middle grounds, broken only here and there by narrow tortuous channels, form an obstruction similar to a partly submerged dam which is sufficient to prevent the shore channel from attaining the same height as the ship channel: this channel is, at the lowest water in the fall, from 0.5 feet to 0.6 feet higher than the former, opposite the Contrecoeur wharf.

It appears from the above remarks, that any gauging that may be necessary in connection with projected dredging operations in the ship channel opposite the parish of Contrecoeur, should, during the low water season at least, be done on the northern side of the outlying islands or along the north shore of the St. Lawrence, in preference to the Contrecoeur wharf or adjoining shore.

Proceeding down stream from Sorel through Lake St. Peter, the semi-diurnal oscillations continue to be very small, indeed at times so small, that they cannot be detected even as low down as Port St. Francis at the extreme eastern end of the lake, except by making extended series of accurate gaugings in calm weather with special apparatus.

The following results of some observations made about the times of the moon's quadratures and at the syzygies during the low water season of 1887 and high water season of 1888, at Port St. Francis and Doucet's Landing opposite Three Rivers, throw some light on the relative importance of the tides felt at these places, the diurnal inequalities, etc.:-

TABLE XIII.

Dates, positions, etc., of tides observed between Sorel and Three Rivers in 1887 and 1888, etc.	Theoretical tidal coefficients.	AVERAGE DAILY RANGES.				FALL FROM SOREL IN MEAN TIDE LEVEL.		Elevation of river at Verchères.	Remarks.
		At Port St. Francis.		At Three Rivers.		To Port St. Francis.	To Three Rivers.		
		From	To	From	To	Feet.	Feet.		
<i>Low water season of 1887.</i>									
October 11 and 12, neaps at beginning of series of gaining tides No. I.	{ 39 to 42 }	0.20	0.70	0.25	0.75	2.30	2.37	22.12	In October the evening tides have generally the greatest amplitudes.
October 18 and 19, springs at end of series of gaining tides No. I.	{ 117 to 116 }	0.81	1.225	1.10	1.42	1.55	1.55	22.30	
<i>High water season of 1888.</i>									
May 19 and 20, neaps at beginning of series of gaining tides No. VII.	{ 46 to 48 }	.....	.....	0.10	0.20	1.10	1.95	31.80	Range at Port St. Francis too small to be deduced from measurements made with ordinary gauging-staff unprotected. In May the morning tides are the most important.
May 26 and 27, springs at end of series of gaining tides No. VII.	{ 107 to 106 }	0.20	0.40	0.47	0.70	0.98	1.75	31.10	

When the river is rising, while the tides are losing in importance, the declivity in the lake surface is, of course, greater than if the river had remained at a uniform level, or was also falling, and on the contrary, with gaining tides and a falling river, the surface slope is smaller than if the river remained at the same level or was in a rising state; all other things being equal in both cases respectively.

During the time simultaneous observations were made at Three Rivers, Port St. Francis, and Sorel, no coincidence of the nature thus described occurred, that could have the effect of increasing or decreasing in a notable manner, the declivity of the waters of Lake St. Peter.

On the 4th of May, 1888, with losing tides, having a coefficient of 44, and the river in a falling condition, the mean level of neaps was at Port St. Francis, lower than at Sorel, by 1.35 feet.

Again, on the 12th May following, when the tides were gaining and the river was rising, the mean level of springs having a coefficient of 82, was at Port St. Francis, below that at Sorel, only 1.15 feet.

We have seen that during series of gaining tides No. I., when the astronomical tidal coefficients fluctuated between 39 and 117, with an average value of 84.84, the water level was raised at Sorel, about (0.75 ft. - 0.45 ft.) = 0.30 ft. As the fall from Sorel to Three Rivers, a distance of over 36 miles along the axis or thalweg of the St. Lawrence, is on an average, less than 2 feet during the low water season and still smaller during the high water season, the effect of a permanent change in the fresh water discharge on the water level may be considered to be sensibly the same, in calm weather, at Sorel, Port St. Francis and Three Rivers. Hence we may take for granted that the effect of a series of gaining tides, such as No. I., on the water level at Port St.

Francis is also to raise it by  $(2.30 - 1.55 - 0.45) = 0.30$  ft., and that the water at Three Rivers will be raised by  $(2.37 - 1.55 - 0.45) = 0.37$  ft. under the same circumstances. Moreover, the probable lowering effects of series of losing tides No. II. may be placed at 0.50 foot at Port St. Francis, the same as at Sorel, and at 0.57 foot at Three Rivers, and the mean value of the effects of two series of tides such as Nos. I. and II., the average importance of which is indicated by coefficients 81, may be put equal to 0.40 foot for Port St. Francis, and 0.47 foot for Three Rivers. The average falls which obtain with such series of gaining and losing tides on the stretch of river under consideration, are, therefore, approximately as follows, when the river stands at a mean elevation of 21.95 feet above datum at Verchères, viz. :—

1. Between Sorel and Port St. Francis :

(a) At neaps of . . . 39,  $2.30 + (0.40 - 0.30) = 2.40$  feet ;

(b) At springs of 117,  $1.55 + (0.40 - 0.30) = 1.65$  feet.

2. Between Sorel and Three Rivers :

(a) At neaps of . . . 39,  $2.37 + (0.40 - 0.30) = 2.47$  feet ;

(b) At springs of 117,  $1.55 + (0.40 - 0.30) = 1.65$  feet.

Also, we may admit as before, that the further lowering of the water below the levels corresponding to the 39 tide just arrived at, which would obtain with a minimum series of tides having coefficients of, say, between 93 and 30, and of an average value of about 63, would be approximately 0.05 foot, both at Port St. Francis and Three Rivers, the same as at Sorel.

As the tide water has already been found to stand at a mean height of 18.35 feet at Sorel, at the time of extreme low water in the river 20.85 feet above datum at Verchères, and when the tide has a minimum amplitude corresponding to coefficient 30, therefore :

(a) The minimum mean tide level is :

1°. At Port St. Francis,  $18.35 - 2.40 = 15.95$  feet above datum ;

2°. At Three Rivers, . . .  $18.35 - 2.47 = 15.88$  feet above datum.

(b) The standard mean tide level at normal lowest water in the river above is, in a similar manner, found to be nearly :

1°. At Port St. Francis,  $19.00 - 2.40 = 16.60$  ;

2°. At Three Rivers, . . .  $19.00 - 2.47 = 16.53$ .

In order to obtain the average high tide levels corresponding to the above we have to add to the mean tide levels of 15.95 feet and 16.60 feet at Port St. Francis :  $0.20 + 0.70$ , or say, more correctly, 0.24 foot, which gives 16.19 and 16.84 for the average high tide levels at the extreme low and standard low or lowest normal stages of the river respectively.

At Three Rivers,  $0.25 + 0.75 =$  say 0.28 ft., has to be added to 15.88 ft. and 16.53 ft., which gives 16.16 ft. and 16.81 ft. for the average high tide levels, at the same respective stages of the river.

The low tide levels at the same stages are arrived at thus

1°. At Port St. Francis

(a) Average low tide level corresponding to extreme low stage of river =

$$\frac{15.95 + (0.20 + 0.70)}{2} = 2.4' = 15.74 \text{ ft.}$$

(b) Average low tide level corresponding to standard low or lowest normal stage of river

$$\frac{16.60 + (0.20 + 0.70)}{2} = 2.4' = 16.39$$

2°. At Three Rivers

(a) Average low tide level corresponding to extreme low stage of river =

$$\frac{15.88 + (0.25 + 0.75)}{2} = 2.8' = 15.66$$

(b) Average low tide level corresponding to standard low or lowest normal stage of river =

$$16.53 - \left\{ \frac{0.25 + 0.75}{2} - 0.28 \right\} = 16.31.$$

By following a train of reasoning similar to that previously adopted herein for determining characteristic high and low and other tide and river levels, I have established for Port St. Francis and Three Rivers, chiefly by means of data to be found in the last table, as shown hereunder, the probable mean and high and low water levels of tides having amplitudes corresponding to the maximum astronomical coefficient 118: (A) when the river is at the extreme high stage, 36.32 ft. above datum at Verchères and 34.07 ft. at Sorel: (B) when the river is at the standard low or lowest normal stage, 21.50 ft. above datum at Verchères and 19.0 ft. at Sorel; the flow being supposed to be permanent, or nearly so in each case.

(A)

1. Decreased fall due to increase of amplitude corresponding to increase of 12 in theoretical tidal coefficient, from 106 to 118:

$$(a) \text{ Sorel to Port St. Francis} = 1.10 - \left\{ \frac{(1.10 - 0.98)(118 - 106)}{106 - 46} = 0.024 \right\} = 1.080 \text{ ft.}$$

$$(b) \text{ Sorel to Three Rivers} = 1.95 - \left\{ \frac{(1.95 - 1.75)(118 - 106)}{106 - 46} = 0.040 \right\} = 1.91 \text{ ft.}$$

2. Fall as further modified by rising of river from 22.30 and 31.30 to 36.32 ft. above datum at Verchères:

$$(a) \text{ Sorel to Pt. St. Francis} = 1.54 - \left\{ \frac{(1.54 - 1.080)(36.32 - 22.30)}{31.30 - 22.30} = 0.72 \right\} = 0.82 \text{ ft.}$$

$$(b) \text{ Sorel to Three Rivers} = 1.54 + \left\{ \frac{(1.91 - 1.54)(36.32 - 22.30)}{31.30 - 22.30} = 0.580 \right\} = 2.12 \text{ ft.}$$

3. Hence in the extreme conditions mentioned, viz., with river discharge at a maximum and tide of greatest amplitude possible, the elevation of the mean tide level is:

$$(a) \text{ At Port St. Francis} \dots\dots\dots 34.07 - 0.82 = 33.25 \text{ ft.}$$

$$(b) \text{ At Three Rivers} \dots\dots\dots 34.07 - 2.12 = 31.95 \text{ ft.}$$

4. Now at Port St. Francis, the tidal intumescence is completely obliterated, even before the river has attained the extreme high stage above defined, for,

$$\left( \frac{0.810 \text{ ft.} + 1.225 \text{ ft.}}{2} = 1.02 \right) - \left( \frac{0.22 + 0.44}{2} = 0.33 \right) = 0.69 \text{ and}$$

$$1.02 - \left( \frac{0.69 (36.32 - 22.30)}{31.10 - 22.30} = 1.07 \right) = -0.05.$$

But at Three Rivers, the tidal undulation is still felt; the mean value of its amplitude being, however, reduced from  $\frac{1.10 + 1.42}{2} = 1.26 \text{ ft.}$  to:

$$1.26 - \left\{ \left( 1.26 - \frac{(0.51 + 0.77)(36.32 - 22.30)}{2} \right) \frac{31.10 - 22.30}{31.10 - 22.30} \right\} = 0.97 \quad \left\{ \right\} = 0.29 \text{ ft.}$$

Therefore, at Three Rivers, under the particular circumstances already described, mean low tide water stands 31.95 ft. — 0.14 ft. = 31.81 ft. above datum, and mean high tide water is..... 31.95 ft. + 0.14 ft. = 32.09 ft. above datum.

(B)

1. Diminished fall due to increase of amplitude corresponding to increase of 2 in theoretical tidal coefficient from 116 to 118, is equal to, say 1.54 ft. between Sorel and Port St. Francis, and also 1.54 ft. between Sorel and Three Rivers.

2. Fall as further modified by lowering of river, from elevation 22.30 ft. to 21.50 ft. at Verchères:



time, for changes of level produced by simultaneous variations in the fresh water discharge.

2. Seven additional diagrams (Ill. XVI. to XXII.), showing the high and low tide loci and corresponding elevations of the river surface at Verchères, were constructed for the gauging stations between Champlain and Quebec, on transparent leather section paper divided into inches and tenths; this paper being found to be more convenient than any other for taking off elevations from the first set of diagrams. Instead of being plotted in the order of the ranges of the corresponding tides, the high and low tide and fluvial levels have been laid down on these new diagrams in the order of the corresponding theoretical coefficients of tidal amplitude; these coefficients being represented by abscissas to a scale of  $\frac{1}{16}$  inch per hundredth, and the elevations of the water to a scale of 2 feet per inch.

The whole of this preliminary work was undertaken with a view of representing graphically, the variations which take place in the high and low water loci of the eight series of gaining and losing tides observed in 1887-88, in reference to increases or decreases in the theoretical importance of the tides and in connection with changes of level that are caused simultaneously by variations in the fresh water discharge. As all tide levels are plotted in the order of the theoretical amplitudes, both gaining and losing series of tides appear on the diagram as affecting the elevation of the water in the same direction. In order, however, that the loci of the various series of water levels represented may be readily distinguished one from the other and compared, each pair or set of high and low water curves has been indicated by a particular kind of line. Thus, the loci of series of gaining tides Nos. I. and V., are shown by continuous full lines; those of series Nos. II. and VI. of losing tides, by small equidistant dots; those, of Nos. III. and VII. of gaining tides, by a succession of long dashes, and those of Nos. IV. and VIII. of losing tides, by dashes alternating with double dots.

Moreover, the curves showing the variable elevation of the water at high and low tide, according to gaugings made during the low water season in 1887, are shown in black, and the corresponding curves for the high water season of 1888 in red, while the loci of the river levels at Verchères, are in blue.

The disposition of the series of high and low water levels observed, side by side, in the order of the theoretical tidal coefficients, affords the advantage of showing at a glance, that apart from the general rise of the high and low water loci of series of gaining tides and the slope of the corresponding loci of losing tides, in proportion to their importance, and independently of the variations of level produced simultaneously in the estuary by fluctuations in the fluvial discharge, each series of high and low tide levels, taken as a whole, occupies moreover a higher or lower position according as the mean height of the fluvial intumescence during the week occupied by the said series, or we may say, approximately, according as the mean theoretical amplitude of the Atlantic wave, is greater or smaller.

The average mean tide, high and low water levels and amplitudes, together with the differences in height between series Nos. I. and III. of gaining, and series Nos. II. and IV. of losing, tides, respectively, which were actually obtained at each tide station between 12th October and 12th November, 1887, when the said series of tides were observed, are given in the following table, in connection with the corresponding average astronomical coefficients of amplitude, units of height and elevations of the river at Verchères:—

TABLE XIV.

Tide Stations.	Numbers of Series.	Tides in each Series, and Dates.	ACTUAL AVERAGES.					Amplitudes corrected for diurnal inequalities.	Elevations of river at Verrhore.	Mean astronomical coefficients of semi-amplitude.	Units of height corresponding to French feet.
			Mean tide levels.	High water levels.	Low water levels.	Differences of height between corresponding serial loci of High and Low water levels.					
			Feet above datum.	Feet above datum.	Feet above datum.						
Graving Dock.	I	14 gaining, Oct. 11 to Oct. 18.	7.534	15.089	0.127	H. W. Locus No. I and 0.85 ft. above No. III	14.963	22.01	81.57	9.12	
	II	13 losing, Oct. 18 to Oct. 25.	7.286	14.238	0.202	H. W. Locus No. II and 0.85 ft. above No. IV.	14.101	22.18	77.00	9.18	
	III	15 gaining, Oct. 25 to Nov. 2.	6.568	13.334	0.107	L. W. Locus No. I and 0.25 ft. above No. III	13.369	21.78	68.00	9.08	
	IV	15 losing, Nov. 2 to Nov. 10.	6.640	13.214	0.080	L. W. Locus No. II and 0.25 ft. above No. IV.	13.128	21.80	65.21	9.00	
		General average, 57 tides.	6.987	13.942	0.072		13.877	21.94	72.70	9.04	
St. Nicholas.	I	14 gaining, Oct. 11 to Oct. 18.	7.968	15.181	0.874	H. W. Locus No. I and 0.80 ft. above No. III	14.304	22.01	81.57	9.12	
	II	13 losing, Oct. 18 to Oct. 25.	7.807	14.537	0.960	H. W. Locus No. II and 0.80 ft. above No. IV.	13.619	22.18	77.00	9.18	
	III	15 gaining, Oct. 25 to Nov. 2.	7.062	13.620	0.590	L. W. Locus No. I and 0.38 ft. above No. III	13.016	21.78	68.00	9.07	
	IV	15 losing, Nov. 2 to Nov. 10.	7.144	13.523	0.739	L. W. Locus No. II and 0.30 ft. above No. IV.	12.78	21.80	65.21	9.00	
		General average, 57 tides.	7.474	14.189	0.787		13.413	21.94	72.70	9.04	
Pointe Platon.	I	14 gaining, Oct. 11 to Oct. 18.	9.775	16.050	3.556	H. W. Locus No. I and 0.75 ft. above No. III	12.444	22.01	81.57	9.12	
	II	13 losing, Oct. 18 to Oct. 25.	9.667	15.523	3.691	H. W. Locus No. II and 0.75 ft. above No. IV.	11.866	22.18	77.00	9.18	
	III	15 gaining, Oct. 25 to Nov. 2.	8.941	14.770	3.209	L. W. Locus No. I and 0.35 ft. above No. III	11.553	21.78	68.00	9.08	
	IV	15 losing, Nov. 2 to Nov. 10.	9.867	14.499	3.251	L. W. Locus No. II and 0.35 ft. above No. IV.	11.237	21.80	65.21	9.00	
		General average, 75 tides.	9.539	15.190	3.423		11.766	21.94	72.70	9.04	

TABLE XIV.—Continued.

Tide stations. Numbers of Series.	Tides in each Series, and Dates.	ACTUAL AVERAGES.						Mean astronomical coefficients of semi-amplitude.	Units of height corresponding to each Series.
		Mean tide levels.	High water lev- els.	Low water levels.	Differences of height between corresponding serial loci of High and Low water levels.	Amplitudes corrected for diurnal inequal- ities.	Elevations of river at Vardöres.		
		Feet above da- tum.	Feet above da- tum.	Feet above da- tum.					
						Ft.			Ft.
I 14	gaining, Oct. 11 to Oct. 18.	12.343	16.356	8.321	H. W. Locus No. I 0.70 ft. above No. III and	7.946	22.01	81.57	4.870
II 13	losing, Oct. 18 to Oct. 25.	12.351	15.965	8.638	H. W. Locus No. II 0.70 ft. above No. IV. Also	7.352	22.18	77.00	4.709
III 15	gaining, Oct. 25 to Nov. 2.	11.527	15.299	7.830	L. W. Locus No. I 0.50 ft. above No. III and	7.455	21.78	68.00	5.481
IV 15	losing, Nov. 2 to Nov. 10.	11.405	15.042	7.814	L. W. Locus No. II 0.50 ft. above No. IV.	7.241	21.80	65.21	5.552
	General average, 57 tides.	11.885	15.647	8.145		7.500	21.94	72.70	5.158
I 14	gaining, Oct. 11 to Oct. 18.	13.561	16.455	10.653	H. W. Locus No. I 0.55 ft. above No. III and	5.724	22.01	81.57	3.508
II 13	losing, Oct. 18 to Oct. 25.	13.647	16.226	10.991	H. W. Locus No. II 0.55 ft. above No. IV. Also	5.228	22.18	77.00	3.403
III 15	gaining, Oct. 25 to Nov. 2.	12.779	15.476	10.140	L. W. Locus No. I 0.40 ft. above No. III and	5.357	21.78	68.00	3.925
IV 15	losing, Nov. 2 to Nov. 10.	12.910	15.389	10.387	L. W. Locus No. II 0.40 ft. above No. IV.	4.962	21.80	65.21	3.766
	General average, 57 tides.	13.201	15.866	10.536		5.333	21.94	72.70	3.649
I 14	gaining, Oct. 11 to Oct. 18.	15.452	16.921	13.969	H. W. Locus No. I 0.48 ft. above No. III and	2.881	22.01	81.57	1.766
II 13	losing, Oct. 18 to Oct. 25.	15.656	16.873	14.372	H. W. Locus No. II 0.48 ft. above No. IV. Also	2.500	22.18	77.00	1.623
III 15	gaining, Oct. 25 to Nov. 2.	14.793	16.010	13.621	L. W. Locus No. I 0.50 ft. above No. III and	2.389	21.78	68.00	1.757
IV 15	losing, Nov. 2 to Nov. 10.	14.782	15.948	13.590	L. W. Locus No. II 0.50 ft. above No. IV.	2.376	21.80	65.21	1.821
	General average, 57 tides.	15.149	16.415	13.883		2.532	21.94	72.70	1.741



serve here to show that even supposing the elevation of the said mean tide level to be accurately known, the errors that would be committed are, in the case of neaps, nearly 85 and 19 per cent, and in case of springs, 83 and 30 per cent greater than the errors which have been found to obtain in European seaports under the most unfavourable conditions of wind and weather, although during the whole time the observations were made and for several days previous, the weather was fair and no high winds were felt at Quebec and vicinity.

These large discrepancies appear to be chiefly due to the following causes: 1st. At spring tides, the whole body of water brought up the St. Lawrence estuary by the Atlantic wave has to be raised vertically several feet higher than at neap tides, and as a good portion of the energy of the fluvial undulation is expended in performing this work, the intumescence formed on the estuary must gain less rapidly in importance than the wave from the ocean which gives rise to it.

2nd. At neaps, the volume of tide water retained in the estuary—which may be looked upon as a very long narrow pond—is smaller than at springs, and the general level corresponding to any one whole phase of the undulations which are continuously being propagated up the St. Lawrence, is therefore lower than at springs and the importance or amplitude of the tides comparatively greater than the theoretical one, as represented by the coefficients in "*L'Annuaire des Marées*." That the volume of tide water which lodges in the estuary, increases with the gaining tides and diminishes when these are losing in importance, is shown in the most striking manner by diagrams Nos. IX., X., XIII. and XIV., which illustrate the movements of the tides at Grondines, St. Jean, Batiscan and Champlain, where the St. Lawrence falls to a lower level at neaps than at springs, while the fresh water discharge and river level at Verchères remain constant. Below Pointe Platon, the low water surface of the stream is generally at a higher level at neaps than at springs; but the filling and emptying of the estuary goes on according to the same law as above this locality, which is clearly shown by diagrams Nos. VI, VII., VIII., XII and XIII., and also by the water levels entered in the last table. It is, moreover, not impossible that the interference of the wave passing through the Straits of Belle Isle with that entering the Gulf through Cabot Strait may contribute, in some measure, to the modification of the theoretical curve of amplitudes which indicates the variations due to astronomical causes, in the importance of the tide waves on the shores of the open Atlantic, and in the vertical position of the summits and troughs of these waves.

In view of the ascertained fact that the general elevation of each weekly series of gaining or losing tides varies with its mean amplitude, it follows that before the part of a change in the water level of the estuary, which is attributable to a corresponding variation in the fluvial discharge, can be correctly established by comparing the elevations of wave summits or troughs determined by the high stage loci of high and low tide levels, respectively, with the elevations of summits or troughs of undulations of equal theoretical importance, determined by corresponding loci for the low stage of the river, it will be necessary either: 1st. To refer both sets of loci to a series of tides, the mean amplitude of which corresponds to a standard theoretical coefficient having a fixed value, such as for instance:  $\frac{81.57 + 77.00 + 68.00 + 65.21}{4} =$  say, 73 or, 2nd. To

affect other corrections that may be found more advantageous for eliminating the difference of height in the said typical water lines, which arises from the inequality in the mean amplitudes of the weekly series of tides in question, or else: 3rd. To select for comparing purposes tides forming part of series having nearly equal mean coefficients of amplitude.

Moreover, it must be borne in mind that the springs which have a maximum theoretical amplitude corresponding to coefficient 118, belong to weekly series for which the mean coefficient of amplitude is, say, about 82, and the neaps of minimum importance corresponding to astronomical coefficient 30, form part of series the mean amplitude of which may be assumed to correspond to coefficient 65.

In series Nos. V. and VI. of high and low tide levels determined during the high water season of 1888, there occurs an interval of about 12 days between the 6th and 18th of May, embracing 24 tides with theoretical coefficients of from 49 to 75, during which period the river was continuously in a rising condition; its surface being raised 4·0 ft., viz.: from 27·50 ft. to 31·50 ft. above datum. During the first four days, viz.: from 6th to 10th May, the water rose gradually only 0·3 ft., and during the last four days, from 14th to 18th May, only 0·75 feet.

The observations and gaugings made during these two periods of 4 days are, on the whole, the best available for ascertaining by direct comparison, the variations in the high and low tide levels which result from an increased or diminished fluvial discharge corresponding to a given rise or fall of the river at Verchères, during the high stage of the Lower St. Lawrence in the spring of the year.

But even here, judging by the relative heights of the loci of series of wave summits and troughs Nos. VI. and VII., during the latter of which series the fresh water discharge was slowly decreasing instead of being on the increase, as during the previous series, the steady and comparatively rapid swelling of the river proper above Verchères, from 10th to 14th May, kept the level of the estuary abnormally high in the vicinity of Quebec between the 14th and 16th or 17th of May, say to the extent of from about 0·2 ft. at Pointe Platon to 0·5 ft. at the Graving Dock, especially at the time of low water. Hence, in order to determine the mean ratio which obtains when the flow is nearly permanent and the tide has an amplitude corresponding to astronomical coefficient 75, between the rise of an estuary at high or low tide caused by an increased fresh water discharge above a typical level corresponding to a standard high stage of the river, or the fall in the estuary below the typical level due to a decreased discharge, and the corresponding change in the fluvial level at Verchères, I have assumed that such standard river and typical high and low tide levels are situated respectively about midways between those of series Nos. VI. and VII. as plotted on the diagrams.

On account of the river falling only some 2½ ft. at Verchères during the whole time occupied by series of gaugings Nos. VII. and VIII., the data afforded by these water measurements can evidently not be applied so advantageously to gain the object just described as the data derived from series Nos. V. and VI.

Still less is it to be expected that the ratio of the changes occurring in the high and low tide levels, to the variations which take place nearly simultaneously in the river levels at Verchères, can be deduced satisfactorily for the low water season, in a direct manner from the four series of observations Nos. I. to IV. made in the fall of 1887, considering that the variations in the fluvial discharge were naturally of much more limited extent than in the case of the high water series of tides Nos. VII. and VIII.

To compare some series of gaugings intermediate between the two monthly sets of gaining and losing series of tides, I. to IV. and V. to VIII., which correspond to the highest and to the lowest stages of the river—had such water measurements been made—with some of the low water series, I. to IV., would probably have been the most satisfactory way of determining the said low water ratios.

Under the circumstances, the best alternative course that would give results sufficiently accurate for the present purpose, appeared to be to establish:

1°. The ratios which the variations in the high and low water levels of a 49 tide, due to a fluctuation of the river at Verchères, between elevations 21·70 ft. and 27·50 ft., in passing from series No. IV. to series No. V., bear to the fluvial fluctuation of (27·50 ft. - 21·70 ft.) = 5·80 ft.

2°. The corresponding ratio for a tide of 75, while the river fluctuates at Verchères, between elevations 21·80 and 27·90 = 6·10 ft.

After, however, these computations were completed, with a view of checking, in a certain manner, the results arrived at, as just described and at the same time securing additional data that would show in a more satisfactory manner the nature of the combined effects of the fluvial and tidal waters on the level of the estuary, I also determined for every station below Champlain, the average variations which obtained in the high and low tide levels of the more extended series Nos. I., III., V. and VII., while

the river rose at Verchères : in the case of neaps of 46, from elevation 21.90 ft. to 31.60 ft. above datum, viz.: 9.7 ft. ; and in the case of springs of 107, from elevation 22.10 ft. to 31.10 ft., viz. : 9.0 ft.

Finally, I concluded that, everything considered, the best course to follow was to take the mean of the two results obtained as above explained.

Let us now compute the values of these ratios *in extenso*, as just explained say for Grondines station, to give an example of the application of the method followed for all the other places.

On referring to diagram No. XIX it will be seen :

(a.) That during gaining weekly series of tides No. V in the spring of 1888 and the succeeding losing series No. VI, when the mean serial coefficients of amplitude were respectively 65.14 and 67.13 :

1st. The high water level of a low neap tide corresponding to coefficient 49, rose at Grondines from 17.70 ft. above datum in series No. V, to 19.95 ft. in series No. VI, or 2.25 feet, while the rise of the river at Verchères was from elevation 27.60 feet to 31.60 feet = 4.0 feet. Deducting, say  $(\frac{0.79}{31})$  foot  $\times .02 = 0.10$  foot from 2.25 feet, on account of the coefficient of mean amplitude in losing series No. VI being greater by  $(0.6713 - 0.6514) = 0.0199$ , than that of gaining series No. V, and denoting the ratio of the average rise or fall or variation,  $V.H.W.$ , in the high water level of a tide with a coefficient of  $\frac{T}{49}$ , at Grondines, to the corresponding variation,  $V.R.$ , of the river between elevations 27.60 feet and 31.60 feet, by :

$$\frac{V.H.W., \frac{T}{49}}{V.R., \left\{ \begin{smallmatrix} 27.60 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}}$$

capitals being generally used in this and other similar expressions given hereafter, to indicate or refer to tide and river levels of the high water season, while corresponding river or tide levels which obtain during the low water season are represented by small letters, we have :

$$\frac{V.H.W., \frac{T}{49}}{V.R., \left\{ \begin{smallmatrix} 27.60 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}} = \frac{(2.25 - 0.1) = 2.15}{(31.60 - 27.60) = 4.00} = 0.538 \text{ ft.} \quad (1)$$

2. The low water level rises, say from 13.20 ft. to 16.75 ft. above datum = 3.55 ft., whence we deduce for average rise or fall at Grondines due to each foot of corresponding change, after deducting  $\left( \frac{0.50}{0.12} \right) \times 0.02$ , or say 0.09 from 3.55, owing to the inequality in the serial mean amplitudes :

$$\frac{V.L.W., \frac{T}{49}}{V.R., \left\{ \begin{smallmatrix} 27.60 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}} = \frac{3.46}{4.00} = 0.865 \text{ ft.} \quad (2)$$

3. The amplitude is diminished from :

$$A_{49, (27.60 \text{ ft.})}^T \text{ to } A_{49, (27.60)}^T - \left[ V.H.W., \frac{T}{49}, \left\{ \begin{smallmatrix} 27.60 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\} - V.L.W., \frac{T}{49}, \left\{ \begin{smallmatrix} 27.60 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\} \right]$$

viz, from  $(17.70 - 13.20 = 4.50)$  to  $(19.95 - 16.76 = 3.20 \text{ ft.})$ , and to :

$$\frac{A_{49, (27.60)}^T - \left[ V.H.W., \frac{T}{49}, \left\{ \begin{smallmatrix} 27.60 \\ \text{to} \\ 31.68 \end{smallmatrix} \right\} - V.L.W., \frac{T}{49}, \left\{ \begin{smallmatrix} 27.60 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\} \right]}{A_{49, (27.60)}^T} = \frac{3.20}{4.50} \quad (3)$$

or 0.710 of its original value, where  $A_{49}^T(27.60 \text{ ft.})$  denotes the tidal amplitude at Grondines during neaps of 49 when the river surface stands at a mean elevation of 27.60 ft. above datum at Verchères.

(b.) That when the Atlantic tides had an amplitude corresponding to coefficient 75 in series Nos. V and VI, with mean astronomical coefficients of 65.14 and 67.13 respectively, a rise of the river at Verchères from 27.80 ft. to 31.10 ft. = 3.30 feet above datum, caused :

1. The high water level at Grondines to rise from 19.35 ft. to 21.15 ft. = 1.80 ft.; little or no correction being needed on account of the inequality of the serial mean amplitudes, whence :

$$\frac{V_{\text{H.W., } 75}^T}{V_{\text{R., } \left\{ \begin{smallmatrix} 27.80 \\ \text{to} \\ 31.10 \end{smallmatrix} \right\}}} = \frac{1.80}{3.30} = 0.545 \text{ ft.} \quad (4)$$

2. The low water level to rise from 13.90 to 16.70 = 2.80 ft., whence :

$$\frac{V_{\text{L.W., } 75}^T}{V_{\text{R., } \left\{ \begin{smallmatrix} 27.80 \\ \text{to} \\ 31.10 \end{smallmatrix} \right\}}} = \frac{2.80}{3.30} = 0.848 \text{ ft.} \quad (5)$$

3. The amplitude  $A_{75}^T(27.80 \text{ ft.})$  is thus reduced to :

$$A_{75}^T(27.80 \text{ ft.}) - \left[ V_{\text{H.W., } 75}^T \left\{ \begin{smallmatrix} 27.80 \\ \text{to} \\ 31.10 \end{smallmatrix} \right\} - V_{\text{L.W., } 75}^T \left\{ \begin{smallmatrix} 27.80 \\ \text{to} \\ 31.10 \end{smallmatrix} \right\} \right]$$

or from (19.35 — 13.95) = 5.45 ft., to (21.15 — 16.70) = 4.45 ft., viz. to :—

$$\frac{A_{75}^T(27.80) - \left[ V_{\text{H.W., } 75}^T \left\{ \begin{smallmatrix} 27.80 \\ \text{to} \\ 31.10 \end{smallmatrix} \right\} - V_{\text{L.W., } 75}^T \left\{ \begin{smallmatrix} 27.80 \\ \text{to} \\ 31.10 \end{smallmatrix} \right\} \right]}{A_{75}^T(27.80)} \quad (6)$$

or to  $\frac{4.45}{5.45} = 0.816$  of its original value.

(c.) That at neaps of 49 in series Nos. IV and V, having nearly equal theoretical coefficients of amplitude, viz. : 65.21 and 65.14, respectively ; and where, therefore, no correction is required on account of any difference that might exist in the mean importance of the said series of tides, we find that for a fluvial rise or fall at Verchères, between elevations 21.70 ft. and 27.60 ft. = 5.90 ft. :

1. The high water level at Grondines rises from 14.25 ft. to 17.70 ft., or falls from 17.70 feet to 14.25 = 3.45 ft., whence :

$$\frac{V_{\text{H.W., } 49}^T}{V_{\text{R., } \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.60 \end{smallmatrix} \right\}}} = \frac{3.45}{5.90} = 0.585 \text{ ft.} \quad (7)$$

2. The low water level is raised from 7.50 to 13.20 = 5.70 ft., or depressed as much, whence :

$$\frac{V_{\text{L.W., } 49}^T}{V_{\text{R., } \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.60 \end{smallmatrix} \right\}}} = \frac{5.70}{5.90} = 0.966 \text{ ft.} \quad (8)$$

3. The amplitude becomes, therefore, diminished from :

$$A_{49, (21.70) \text{ to } 27.80}^T - \left[ V_{H.W., 49, \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}^T - V_{L.W., 49, \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}^T \right]$$

or from 6.75 to  $(17.70 - 13.20) = 4.50$  ft., viz. to :

$$\frac{A_{49, (27.80)}^T - \left[ V_{H.W., 49, \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}^T - V_{L.W., 49, \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}^T \right]}{A_{49, (27.80)}^T} \quad (9)$$

or to  $\frac{4.50}{6.75} = 0.667$  of its first value.

(d.) That at springs of 75 in series Nos. IV. and V., for a rise of the river at Verchères from 21.70 to 27.80 = 6.10 ft. :

1. The high water level is elevated at Grondines from 15.35 ft. to 19.35 ft. = 4.00 feet, whence :

$$\frac{V_{H.W., 75, \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}^T}{V_{R., \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}^T} = \frac{4.00}{6.10} = 0.656. \quad (10)$$

2. The low tide level is raised from 7.95 ft. to 13.90 ft. = 6.0 ft. above datum, whence :

$$\frac{V_{L.W., 75, \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}^T}{V_{R., \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}^T} = \frac{6.00}{6.10} = 0.983. \quad (11)$$

3. The amplitudes are diminished from :

$$A_{75, (21.70) \text{ to } 27.80}^T - \left[ V_{H.W., 75, \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}^T - V_{L.W., 75, \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}^T \right]$$

or from 15.35 — 7.90 = 7.45 to 19.35 — 13.90 = 5.45 ft., viz. to :

$$\frac{A_{75, (21.70) \text{ to } 27.80}^T - \left[ V_{H.W., 75, \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}^T - V_{L.W., 75, \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}^T \right]}{A_{75, (21.70)}^T} \quad (12)$$

or  $\frac{5.54}{7.45} = 0.731$  of their first value.

(e.) That at neaps of importance, 46, in series Nos. III. and VI., the mean amplitude coefficients of which are 68.00 and 67.13, and where consequently the correction required when the mean serial amplitudes differ materially from each other may also be omitted, it is found that for a rise or a fall of the river at Verchères of 9.8 feet, between the elevations of 21.80 ft. and 31.60 ft. above datum :

1. The high water level becomes elevated or depressed at Grondines 5.35 ft., between the elevations of 14.60 ft. and 19.95 ft., whence :

$$\frac{V_{H.W., 46, \left\{ \begin{smallmatrix} 21.80 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}}^T}{V_{R., \left\{ \begin{smallmatrix} 21.80 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}}^T} = \frac{5.35}{9.80} = 0.546 \text{ ft.} \quad (13)$$

2. The low water level varies 9.00 ft., between the heights of 7.75 and 16.75 above datum, wherefore :

$$\frac{V_{L.W., 46}^{\tau}}{V_{H., \left\{ \begin{smallmatrix} 21.80 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}}^{\tau}} = \frac{9.00}{9.80} = 0.918 \text{ ft.} \quad (14)$$

3. The amplitude becomes, therefore, diminished from :

$$A_{46, (21.80) \text{ to } 46, (21.30)}^{\tau} - \left[ V_{H.W., 46, \left\{ \begin{smallmatrix} 21.80 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}}^{\tau} - V_{L.W., 46, \left\{ \begin{smallmatrix} 21.80 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}}^{\tau} \right]$$

or from (14.60 - 7.75 = 6.85 ft.) to (19.95 - 16.75 = 3.20 ft.) viz., to:

$$A_{46, (21.80)}^{\tau} - \left[ V_{H.W., 46, \left\{ \begin{smallmatrix} 21.80 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}}^{\tau} - V_{L.W., 46, \left\{ \begin{smallmatrix} 21.80 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}}^{\tau} \right] \quad (15)$$

$$A_{46, (21.80)}^{\tau}$$

or  $\frac{3.20}{6.80} = 0.467$  of its first value.

(c) That at springs of 107 in series Nos. II. and VII., with weekly mean amplitudes corresponding to coefficients 77 and 78 respectively, it is found that for a rise of the river at Vercheres from 22.50 to 31.00 ft. above datum = 8.5 ft. :

1. The high tide level is elevated at Grondines 5.40 ft., from the height of 17.25 ft. to 22.65 ft. above datum, whence :

$$\frac{V_{H.W., 107}^{\tau}}{V_{H., \left\{ \begin{smallmatrix} 22.50 \\ \text{to} \\ 31.00 \end{smallmatrix} \right\}}^{\tau}} = \frac{5.40}{8.50} = 0.635 \text{ ft.} \quad (16)$$

2. The low tide level is raised from 9.50 to 17.30 ft. above datum = 7.80 ft., whence :

$$\frac{V_{L.W., 107}^{\tau}}{V_{H., \left\{ \begin{smallmatrix} 22.50 \\ \text{to} \\ 31.00 \end{smallmatrix} \right\}}^{\tau}} = \frac{7.80}{8.50} = 0.918 \text{ ft.} \quad (17)$$

3. The amplitude is diminished from

$$A_{107, 22.50 \text{ to } 31.00}^{\tau} - \left[ V_{H.W., 107, \left\{ \begin{smallmatrix} 22.50 \\ \text{to} \\ 31.00 \end{smallmatrix} \right\}}^{\tau} - V_{L.W., 107, \left\{ \begin{smallmatrix} 22.50 \\ \text{to} \\ 31.00 \end{smallmatrix} \right\}}^{\tau} \right]$$

or from (22.65 - 17.25 = 5.40 ft.) to (22.65 - 17.30 = 5.35 ft.) viz., to:

$$A_{107, 22.50}^{\tau} - \left[ V_{H.W., 107, \left\{ \begin{smallmatrix} 22.50 \\ \text{to} \\ 31.00 \end{smallmatrix} \right\}}^{\tau} - V_{L.W., 107, \left\{ \begin{smallmatrix} 22.50 \\ \text{to} \\ 31.00 \end{smallmatrix} \right\}}^{\tau} \right] \quad (18)$$

$$A_{107, 22.50}^{\tau}$$

or  $\frac{5.35}{5.40} = 0.991$  of its first value.

As shown in the following table, the heights of the water surface are established at the heights of the river at Vercheres from 22.50 to 31.00 ft. above datum, and the high and low tide levels are established at Grondines.

At the high stage of the river, the water surface is from 27.60 to 31.00 ft. above datum, and the range of ratio  $\frac{V_{H.W.}}{V_{H.}}$  for

the high tide level per unit of tidal importance or theoretical amplitude, and for amplitudes corresponding to coefficients between 49 and 75, is, according to the above relations :

$$C_{\text{H.W.}} \left\{ \begin{smallmatrix} 27.60 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\} = \frac{V_{\text{H.W.}, 75}^{\text{T.}}}{V_{\text{R.}} \left\{ \begin{smallmatrix} 27.80 \\ \text{to} \\ 31.10 \end{smallmatrix} \right\}} - \frac{V_{\text{H.W.}, 49}^{\text{T.}}}{V_{\text{R.}} \left\{ \begin{smallmatrix} 27.60 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}} = \frac{0.545 - 0.538}{75 - 49} = +0.00027. \quad (19)$$

Hence the approximate value of  $\frac{V_{\text{H.W.}}}{V_{\text{R.}}}$  at the highest springs and the lowest neaps

possible, during the high water season when the river stands between 27.60 and 30.60 above datum at Verchères, are :

$$\frac{V_{\text{H.W.}}}{V_{\text{R.}} \left\{ \begin{smallmatrix} 27.60 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}} \text{ for } \begin{cases} \text{T.}_{118} = 0.545 + (118-75)(0.00027) = 0.5566. \\ \text{T.}_{30} = 0.538 - (49-30)(0.00027) = 0.5331. \end{cases} \quad (20)$$

Now, by drawing a right line AB on diagram No. XIX., to indicate the general direction of the locus of high tide levels for the weekly series of gaining tides No. VII during which the St. Lawrence fell at Verchères only about 0.4 ft., while its mean elevation at this place was 31.20 ft., and producing this line upward past ordinate 118 and downwards to ordinate 30, the intersection of AB with the former ordinate is found to be at a height of 23.27 ft., and its intersection with the latter ordinate, 18.77 ft. above datum, so that we can put :

$$\begin{matrix} \text{E.}_{\text{H.W.}} \\ \text{for} \\ \text{R.}, (31.20) \end{matrix} \text{ for } \begin{cases} \text{T.}_{118} = 23.27 \text{ ft.} \\ \text{T.}_{30} = 18.77 \text{ ft.} \end{cases} \quad (21)$$

The right line AB, shown on the diagram (No. XIX.), it will be noticed, does not strictly follow the average or general direction of the high tide levels or wave summits of series No. VII.; but has a slightly greater inclination to the horizon. This is due to my having applied an approximate correction, owing to the slight flattening of the high water locus corresponding to a perfectly uniform fluvial discharge which must have resulted from the continuous, though slow, falling off in the said discharge during the weekly series in question. The inclination given to AB is such that if a parallel was run through the intersection of loci Nos. VII. and VIII. it would cut off on its upper side about one-quarter of the angular space comprised between them; the reason being that during series No. VIII., for which the average astronomical coefficient of amplitude is nearly the same as for No. VII., viz : 75.7, the river fell on the whole about three times as rapidly as during series No. VII.

If instead of being 31.20 ft. above datum at Verchères the river surface had stood at the greatest elevation on record, viz: at 36.32, and if instead of 78 the mean serial coefficients of amplitude had been 82 and 65, the summit of the fluvial waves of maximum importance would have reached the following elevations, viz. :

$$\begin{matrix} \text{E.}_{\text{H.W.}} \\ \text{for} \\ \text{R.}, (36.32) \end{matrix} \text{ for } \begin{cases} \text{T.}_{118} = 23.27 + (36.32 - 31.20)(0.5566) + \left( \frac{.70}{13} \right) (82-78) = 26.34 \text{ ft.} \\ \text{T.}_{30} = 18.77 + (36.32 - 31.20)(0.5331) - \left( \frac{.70}{13} \right) (78-65) = 20.80 \text{ ft.} \end{cases} \quad (22)$$

The elevation of 26.34 above datum indicates the probable extreme height to which spring tides of the maximum importance of 118 would rise at Grondines, at high water during the season of navigation, and 20.80 the lowest point to which neaps of the mini-

imum importance of 30 would fall, at low water when the river is at the extreme high stage of 36.32 ft. at Verchères; leaving out of consideration the effects of the tidal diurnal inequalities on the level of the estuary as well as those of persistent high winds, and taking for granted that such maximum and minimum tides may occur during the month of May. But according to the tables of tidal coefficients (centièmes) at the syzygies, which have been published annually in "La Connaissance des Temps" for the 19 years from 1870 to 1889, during which period the moon's nodes made a complete revolution, the tide of greatest importance that may be expected to occur during the month of May corresponds to a coefficient of 108 instead of 118.

Now, according to locus AB of high tide levels drawn on Ill. No. XIX, the elevation of high water of a 108 tide, with the river 31.20 ft. above datum, at Verchères, is at Grondines:

$$E_{\substack{\text{H.W., 108} \\ \text{for} \\ \text{R., (31.20)}}}^{\text{T.}} = 22.77 \text{ ft.} \quad (23)$$

Hence, the greatest height to which springs can rise at Grondines, in May, or at the beginning of June, in the conditions just mentioned is:

$$E_{\substack{\text{H.W., 118} \\ \text{for} \\ \text{R., (36.32)}}}^{\text{T.}} = 22.77 + \{0.545 + (108 - 75)(+0.00027)\} \{36.32 - 31.20\} = 25.60 \text{ ft.} \quad (24)$$

During the interval when the St. Lawrence fluctuated at Verchères, on an average, between  $\frac{21.70 + 21.80}{2} = 21.75$  ft., in weekly series of losing tides No. IV., with a mean

importance of 65.21, and between  $\frac{27.50 + 27.90}{2} = 27.70$  ft., above datum, in series of gain-

ing tides No. V. having very nearly the same mean importance as series No. IV., viz.: 65.14, and when, moreover, the astronomical coefficients of tidal amplitude varied between 49 and

75—the average change of the low tide level ratio, —  $\frac{V_{\text{L.W., } \left\{ \begin{smallmatrix} \text{T.} \\ 49 \\ \text{to} \\ 75 \end{smallmatrix} \right\}}}{V_{\text{R., } \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.90 \end{smallmatrix} \right\}}}$  — per unit of increase or

decrease in the theoretical coefficient of amplitude was:

$$C_{\substack{\text{L.W., } \left\{ \begin{smallmatrix} \text{T.} \\ 75 \\ \text{or, } \left\{ \begin{smallmatrix} \text{to} \\ \text{L.W., } 49 \end{smallmatrix} \right\} \end{smallmatrix} \right\}}}^{\text{V.}} = \frac{V_{\text{L.W., } \left\{ \begin{smallmatrix} \text{T.} \\ 75 \end{smallmatrix} \right\}}}{V_{\text{R., } \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.90 \end{smallmatrix} \right\}}} - \frac{V_{\text{L.W., } \left\{ \begin{smallmatrix} \text{T.} \\ 49 \end{smallmatrix} \right\}}}{V_{\text{R., } \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.90 \end{smallmatrix} \right\}}} = \frac{0.967 - 0.966}{26} = 0.00003 \quad (25)$$

Assuming now that the said low tide level ratio continues to vary, approximately, at the same uniform rate of 0.00003 ft. for each unit of increase in the tidal coefficients, while these diminish from 49 to 30 and increase from 75 to 118, we have:

$$\begin{aligned} V_{\text{L.W., } \left\{ \begin{smallmatrix} \text{T.} \\ 30 \end{smallmatrix} \right\}}^{\text{V.}} &= 0.966 - (49 - 30)(0.00003) = 0.9654 \\ V_{\text{R., } (21.30)}^{\text{T.}} &= 0.967 + (118 - 75)(0.00003) = 0.9683 \end{aligned} \quad (26)$$

where the expression  $V_{\text{R., } (21.30)}^{\text{L.W., } \left\{ \begin{smallmatrix} \text{T.} \\ 30 \end{smallmatrix} \right\}}$  denotes, in general, the variation of the low tide

level per foot of fluvial fluctuation, at Verchères, about the time the fresh water discharge is a minimum, and when those tides occur, which draw off the water of the ——— to the lowest possible level, in the locality under consideration, whether at ——— springs of 118, or at minimum neaps of 30.

Again, during the intervals when the St. Lawrence fluctuated at Verchères, on an average, between  $\frac{21.90 + 22.20}{2} = 22.05$  ft., in series No. I having a mean importance of 81.57, and  $\frac{31.60 + 31.10}{2} = 31.35$  ft. above datum, in series No. VII, the mean theoretical importance of which corresponds to coefficient 78, and when the astronomical coefficients of amplitude varied between 46 and 107, the mean change of the

low tide level ratio,  $\frac{V_{L.w., \left\{ \begin{smallmatrix} T. \\ 46 \\ \text{to} \\ 107 \end{smallmatrix} \right\}}}{V_{R., \left\{ \begin{smallmatrix} 21.80 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}}}$  per unit of increase or decrease in the theoretical coefficient of amplitude, was :

$$C_{L.w., \left\{ \begin{smallmatrix} T. \\ 107 \\ \text{to} \\ L.w. \\ 46 \end{smallmatrix} \right\}} = \frac{V_{L.w., \left\{ \begin{smallmatrix} T. \\ 107 \\ \text{to} \\ 22.50 \end{smallmatrix} \right\}}}{V_{R., \left\{ \begin{smallmatrix} 22.50 \\ \text{to} \\ 31.00 \end{smallmatrix} \right\}}} - \frac{V_{L.w., \left\{ \begin{smallmatrix} T. \\ 46 \\ \text{to} \\ 21.80 \end{smallmatrix} \right\}}}{V_{R., \left\{ \begin{smallmatrix} 21.80 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}}} = \frac{0.924}{107 - 46} - \frac{0.918}{61} = + 0.00010 \quad (27)$$

With the aid of this equation we arrive at :

$$\begin{aligned} \frac{V_{L.w.}}{V_{R., (21.50)}} \text{ for } \begin{matrix} \nearrow T. \\ 30 \\ \searrow T. \\ 118 \end{matrix} &= 0.918 - (46.30) (0.00010) = 0.9160 \\ \frac{V_{L.w.}}{V_{R., (21.50)}} \text{ for } \begin{matrix} \nearrow T. \\ 30 \\ \searrow T. \\ 118 \end{matrix} &= 0.924 - (118.107) (0.00010) = 0.9250 \end{aligned} \quad (28)$$

Finally taking the mean of (26) and (28) :

$$\frac{V_{L.w.}}{V_{R., (21.50)}} \text{ for } \begin{matrix} \nearrow T. \\ 30 \\ \searrow T. \\ 118 \end{matrix} = 0.9407 \quad (29)$$

is obtained.

If now we produce down to ordinate 30 and up to ordinate 118, the line  $\overline{cd}$  drawn on diagram No. XIX., between ordinates 86 and 44, to indicate the general rate at which the low tide locus was lowered at Grondines, during series No. IV. of losing tides observed, while the river stood at an average elevation of 21.80 ft. at Verchères, without at any time having passed more than 0.2 ft. to either side of the said level and when the mean serial coefficient of tidal importance was as low as 65.21—we find by direct scale measurement of the diagram, that the elevations of low water of the tides of minimum and maximum amplitude, viz. : those corresponding to coefficients and ordinates 30 and 118 respectively, are :

$$\begin{aligned} E_{L.w.} \text{ for } \begin{matrix} \nearrow T. \\ 30 \\ \searrow T. \\ 158 \end{matrix} &= 7.17 \text{ ft.} \\ E_{R., (21.80)} &= 8.27 \text{ ft.} \end{aligned}$$

But as the mean theoretical coefficient of weekly series of gaining or losing tides which comprise springs of maximum astronomical importance is about 82, instead of 65.21, we must, according to table XIV., add about 0.50 ft. to 8.27 ft., in order to arrive at the proper elevation of low water of the tide of maximum amplitude at Grondines, with river 21.80 ft. above datum at Verchères, whence :

$$\begin{aligned} E_{L.w.} \text{ for } \begin{matrix} \nearrow T. \\ 30 \\ \searrow T. \\ 118 \end{matrix} &= 7.17 \text{ ft.} \\ E_{R., (21.80)} &= (8.27 + 0.50) = 8.77 \text{ ft.} \end{aligned} \quad (30)$$

At the extreme low stage of the river, when the water is only 20.85 ft. above datum at Verchères, the elevations of the low water levels, or troughs of the said tidal undulations of minimum and maximum importance are, therefore :

$$E_{l. w.} \text{ for } \begin{cases} T_{30} = 7.17 - (21.80 - 20.85) (0.9407) = 6.277 \text{ ft.} \\ T_{118} = 8.77 - (21.80 - 20.85) (0.9466) = 7.861 \text{ ft.} \end{cases} \quad (31)$$

At the low stage of the river, 21.48 ft., or say 21.50 ft. above datum at Verchères, corresponding very nearly to 16.0 ft. on the sill of old lock No. 1, Lachine Canal, called standard low water in this report, and to which I have suggested all the soundings should be reduced, the heights of low water of the same tides of least and greatest amplitude are :

$$E_{l. w.} \text{ for } \begin{cases} T_{30} = 7.17 - (21.80 - 21.50) (0.9407) = 6.888 \text{ ft.} \\ T_{118} = 8.77 - (21.80 - 21.50) (0.9466) = 8.486 \text{ ft.} \end{cases} \quad (32)$$

The lowest points to which the troughs of the fluvial waves of minimum and maximum importance can descend, when the river stands at the extreme high and highest known stage of 36.32 ft. above datum at Verchères, has been determined approximately as follows—always, as heretofore, independently of variations due to diurnal tidal inequalities and abnormal fluctuations caused by persistent high winds, etc.—and the mean coefficient of amplitude of the series of which the first mentioned tidal intumescence forms part, being assumed at 65 and the mean coefficient of the series of tides to which the other wave, viz., that of maximum amplitude belongs, at about 82.

During the two periods of the high water season included in series Nos. V and VI, for which the average coefficients of serial importance were, as already stated, 65.14 and 67.13, when the St. Lawrence stood between 27.60 and 31.60 ft. above datum at Verchères and the theoretical coefficients of tidal amplitude varied between 49 and 75—the

mean change of ratio:  $V_{w.} \left( \frac{T_{40}}{T_{75}} \right)$  for the low tide level, per unit of increase or

$$V_{w.} \left( \frac{27.60}{31.60} \right)$$

decrease in the last mentioned coefficient, was :

$$C_{w.} \left( \frac{1}{75} \right) V_{w.} \left( \frac{27.60}{31.60} \right) = \frac{V_{w.} \left( \frac{27.60}{31.60} \right)}{75} = \frac{0.848 - 0.865}{26} = -0.00065 \quad (33)$$

Hence

$$\begin{aligned} V_{w.} \left( \frac{27.60}{31.60} \right) &= 0.865 - 0.00065 = 0.86435 \\ V_{w.} \left( \frac{27.60}{31.60} \right) &= 0.865 - 0.00065 = 0.86435 \end{aligned} \quad (34)$$

But in proceeding back to ordinate 30 and up to ordinate 118, the line C D drawn on Diagram No. XIX, we are to follow the general use of the locus of the low tide levels of series of gauging data No. V, having a mean coefficient of amplitude equal to 78, when the river was at its average elevation of 21.50 ft. at Verchères, from which it had varied but 0.2 ft. either way in a whole week, and the tidal coefficients increased from 49 to 75, the water as already stated, we had, according to scale of measurements made on the diagram, that the low water levels of the tides of minimum and maximum amplitude are respectively 6.277 and 7.861 ft. above datum, that is to say, we may put :

$$E_{L.W., R., (31.20)} \text{ for } \begin{matrix} \nearrow T. \\ \searrow T. \end{matrix} \begin{matrix} 30 \\ 118 \end{matrix} = \begin{matrix} 16.07 \text{ ft.} \\ 16.87 \text{ ft.} \end{matrix} \quad (35)$$

If, instead of standing 31.20 ft. above datum, the river surface had been at the extreme height of 36.32 ft at Verchères, and the coefficient of average serial amplitude 82 instead of 78, the elevations of the troughs of the said tides of minimum and maximum amplitude would have been at Grondines :

$$E_{L.W., R., (36.32)} \text{ for } \begin{matrix} \nearrow T. \\ \searrow T. \end{matrix} \begin{matrix} 30 \\ 118 \end{matrix} = \begin{matrix} 16.07 + (36.32 - 31.20) 0.877 + \left(\frac{.50}{12}\right) (82.78) = 20.73. \\ 16.87 + (36.32 - 31.20) 0.820 + \left(\frac{.50}{12}\right) (82.78) = 21.23. \end{matrix} \quad (36)$$

Finally, during the time when the St. Lawrence fluctuated at Verchères between 21.70 and 27.80 in series of tides Nos. IV and V, the mean theoretical coefficients of amplitude of which are nearly equal to each other, viz.: 65.21 and 65.14, the average

rate of change of ratio  $\frac{V_{H.W., \left\{ \begin{smallmatrix} T. \\ 49 \\ \text{to} \\ 75 \end{smallmatrix} \right\}}}{V_{R., \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}}$  for the high tide level per unit of variation in the tidal coefficient, was at Grondines :

$$C_{H.W., \left\{ \begin{smallmatrix} T. \\ 75 \\ \text{to} \\ A.W. \\ 75 \end{smallmatrix} \right\}} = \frac{V_{H.W., \left\{ \begin{smallmatrix} T. \\ 75 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}}{V_{R., \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.80 \end{smallmatrix} \right\}}} - \frac{V_{H.W., \left\{ \begin{smallmatrix} T. \\ 49 \\ \text{to} \\ 27.60 \end{smallmatrix} \right\}}}{V_{R., \left\{ \begin{smallmatrix} 21.70 \\ \text{to} \\ 27.60 \end{smallmatrix} \right\}}} = \frac{0.656 - 0.585}{75 - 49} = \frac{0.071}{26} = 0.00272. \quad (37)$$

Whence we deduce, approximately, for values of ratio  $\frac{V_{H.W.}}{V_{R.}}$  at the least neaps and

the greatest possible springs, when the river surface stands between 21.70 and 27.80 ft. above datum at Verchères, and we may assume, also for all river levels down to elevation 21 :

$$\frac{V_{H.W.}}{V_{R., (21.50)}} \text{ for } \begin{matrix} \nearrow T. \\ \searrow T. \end{matrix} \begin{matrix} 30 \\ 118 \end{matrix} = \begin{matrix} 0.585 - (49-30)(0.00272) = 0.53332. \\ 0.656 - (118-75)(0.00272) = 0.77296. \end{matrix} \quad (38)$$

Again, with river fluctuations at Verchères, between 21.80 and 31.60 during series Nos. III and IV, having also nearly equal mean theoretical coefficients of amplitude, viz.: 68.00 and 67.13, respectively, and where, consequently, no correction is required in this connection, we have for Grondines :

$$C_{H.W., \left\{ \begin{smallmatrix} T. \\ 46 \\ \text{to} \\ A.W. \\ 107 \end{smallmatrix} \right\}} = \frac{V_{H.W., \left\{ \begin{smallmatrix} T. \\ 107 \\ \text{to} \\ 31.10 \end{smallmatrix} \right\}}}{V_{R., \left\{ \begin{smallmatrix} 22.60 \\ \text{to} \\ 31.10 \end{smallmatrix} \right\}}} - \frac{V_{H.W., \left\{ \begin{smallmatrix} T. \\ 46 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}}}{V_{R., \left\{ \begin{smallmatrix} 21.80 \\ \text{to} \\ 31.60 \end{smallmatrix} \right\}}} = \frac{0.635 - 0.546}{107 - 46} = \frac{0.089}{61} = 0.00146. \quad (39)$$

Hence we may put :

$$\frac{V_{H.W.}}{V_{R., (21.50)}} \text{ for } \begin{matrix} \nearrow T. \\ \searrow T. \end{matrix} \begin{matrix} 30 \\ 118 \end{matrix} = \begin{matrix} 0.546 - (46-30)(0.00146) = 0.52264. \\ 0.625 - (118-107)(0.00146) = 0.65106. \end{matrix} \quad (40)$$

Taking the arithmetical mean of :

$V_{h.w.}^n$  and  $V_{h.w.}^n$ , we obtain :

$V_{h.w.}^n(21.50)$  and  $V_{h.w.}^n(21.50)$

$$V_{h.w.}^n \text{ for } \tau_{30} = \frac{0.53332 + 0.52264}{2} = 0.52798. \quad (41)$$

$$V_{h.w.}^n \text{ for } \tau_{118} = \frac{0.07296 + 0.65106}{2} = 0.36201.$$

By producing down to ordinate 30 and up to ordinate 118, the line  $\overline{a b}$  drawn on diagram No. XIX, between ordinates 39 and 117 to indicate, in general, the locus of high tide levels at Girondines, during series of gaining and losing tides Nos. I and II while the water, stood at an average elevation of 21.10 ft. at Vercheres, we find by actual scale measurement on the said diagram, that the elevations of high water of the neap tides of minimum amplitude and the springs of maximum amplitude are, under such circumstances :

$$E_{h.w.}^n \text{ for } \tau_{30} = 13.97 \text{ ft.} \quad (41\frac{1}{2})$$

$$E_{h.w.}^n \text{ for } \tau_{118} = 17.57 \text{ ft.}$$

The maximum, however, of the mean theoretical coefficient of series of tides Nos. I and II being 79.27, while the maximum actual coefficient is only about 65, the level of 14.50 above datum does not strictly represent the average elevation which wave summits may reach at epochs when the water stands at the mean level of 21.10 at Vercheres.

Assuming, as in Table XIX, we have 7.50 ft. from the said height of 14.50 we obtain as the average elevation of the summit of high water of the tide wave of minimum amplitude at Girondines :

$$E_{h.w.}^n \text{ for } \tau_{30} = 13.97 \text{ ft.} \quad (42)$$

It is assumed the stage is 10 ft. or 3.05 m. above the surface is 21.50 ft. above datum at Vercheres and 10 ft. above low-water at the lock No. 1, Lachine Canal. The difference between these two minimum and maximum importance are 3.05 ft.

$$E_{h.w.}^n \text{ for } \tau_{30} = 13.97 \text{ ft.} \quad (43)$$

$$E_{h.w.}^n \text{ for } \tau_{118} = 17.44 \text{ ft.}$$

These values being now known, the elevation of the water level of the estuary, at any epoch, may be found, and the time of high water, corresponding to those established, as shown in Table XIX, may be determined by following similar methods. The elevation of the water level of the estuary, at any epoch, may be found, as in each case are given in Table XIX.

TABLE XV.

	Levin Graving Dock.	St. Nicholas.	Point Platon.	Grandines.	St. Jean des Chadons.	Batiscan.	Champlain.
(1)	$\frac{V_{H.W., 49}^T}{V_{R., \left( \begin{smallmatrix} 27 \cdot 60 \\ 31 \cdot 60 \end{smallmatrix} \right)}^T}$	0.192	0.245	0.308	0.538	0.795	0.870 (1)
(2)	$\frac{V_{L.W., 49}^T}{V_{R., \left( \begin{smallmatrix} 27 \cdot 60 \\ 31 \cdot 60 \end{smallmatrix} \right)}^T}$	0.265	0.300	0.550	0.865	0.905	0.947 (2)
(3)	$\frac{A_{T, 49}^T (27 \cdot 60) - \left[ V_{H.W., 49, \left( \begin{smallmatrix} 27 \cdot 60 \\ 31 \cdot 60 \end{smallmatrix} \right)}^T - V_{L.W., 49, \left( \begin{smallmatrix} 27 \cdot 60 \\ 31 \cdot 60 \end{smallmatrix} \right)}^T \right]}{A_{T, 49}^T (27 \cdot 90)}$	0.975	0.980	0.997	0.710	0.633	0.612 (3)
(4)	$\frac{V_{H.W., 75}^T}{V_{R., \left( \begin{smallmatrix} 27 \cdot 80 \\ 31 \cdot 10 \end{smallmatrix} \right)}^T}$	0.179	0.230	0.298	0.545	0.864	0.894 (4)
(5)	$\frac{V_{L.W., 75}^T}{V_{R., \left( \begin{smallmatrix} 27 \cdot 80 \\ 31 \cdot 10 \end{smallmatrix} \right)}^T}$	0.268	0.343	0.597	0.848	0.939	0.955 (5)
(6)	$\frac{A_{T, 75}^T (27 \cdot 60) - \left[ V_{H.W., 75, \left( \begin{smallmatrix} 27 \cdot 60 \\ 31 \cdot 10 \end{smallmatrix} \right)}^T - V_{L.W., 75, \left( \begin{smallmatrix} 27 \cdot 80 \\ 31 \cdot 10 \end{smallmatrix} \right)}^T \right]}{A_{T, 75}^T (27 \cdot 80)}$	0.971	0.973	0.911	0.816	0.833	0.826 (6)

TABLE XV—Continued.

	Levin Graving Dock.	St. Nicholas.	Point Platon.	Grondines.	St. Jean des Châllons.	Batiscan.	ChAMPLAIN.
(7) $V_{H.W., 49}^{T, (21\ 70)} V_{R., (27\ 60)}^{T, (21\ 70)}$	0.246	0.364	0.432	0.585	0.712	0.808	0.932 (7)
(8) $V_{L.W., 49}^{T, (21\ 70)} V_{R., (27\ 60)}^{T, (21\ 70)}$	0.263	0.373	0.635	0.966	1.042	1.059	1.060 (8)
(9) $\Lambda_{49}^{T, (27\ 60)} \left[ V_{H.W., 49}^{T, (21\ 70)} V_{L.W., 49}^{T, (21\ 70)} \right] \Lambda_{49}^{T, (27\ 60)}$	0.991	0.995	0.887	0.667	0.589	0.558	0.516 (9)
(10) $V_{H.W., 75}^{T, (21\ 70)} V_{R., (27\ 80)}^{T, (21\ 70)}$	0.262	0.377	0.696	0.656	0.721	0.861	0.918 (10)
(11) $V_{L.W., 75}^{T, (21\ 70)} V_{R., (27\ 80)}^{T, (21\ 70)}$	0.295	0.442	0.680	0.997	1.016	1.033	1.049 (11)
(12) $\Lambda_{75}^{T, (21\ 70)} \left[ V_{H.W., 75}^{T, (21\ 70)} V_{L.W., 75}^{T, (21\ 70)} \right] \Lambda_{75}^{T, (21\ 70)}$	0.986	0.970	0.962	0.745	0.664	0.588	0.589 (12)

(13)	$\frac{V_{H.W., 46}^T}{V_{R., (21.80)}^{T_{L_0}}}$	0.114	0.316	.307	0.546	0.700	0.867	0.923	(13)
(14)	$\frac{V_{L.W., 46}^T}{V_{R., (21.80)}^{T_{L_0}}}$	0.245	0.352	0.612	0.918	0.979	0.996	1.031	(14)
(15)	$\frac{A_{46}^{T_{L_0}} \left[ \frac{V_{H.W., 46}^T}{V_{L.W., 46}^{T_{L_0}}} - \frac{V_{L.W., 46}^T}{V_{L.W., 46}^{T_{L_0}}} \right]}{A_{46}^{T_{L_0}} (21.80)}$	0.968	0.986	0.769	0.546	0.442	0.375	0.344	(15)
(16)	$\frac{V_{H.W., 107}^T}{V_{R., (22.50)}^{T_{L_0}}}$	0.224	0.341	0.600	0.635	0.712	0.794	0.882	(16)
(17)	$\frac{V_{L.W., 107}^T}{V_{R., (22.50)}^{T_{L_0}}}$	0.270	0.400	0.647	0.924	0.941	0.947	1.000	(17)
(18)	$\frac{A_{107}^{T_{L_0}} \left[ \frac{V_{H.W., 107}^T}{V_{L.W., 107}^{T_{L_0}}} - \frac{V_{L.W., 107}^T}{V_{L.W., 107}^{T_{L_0}}} \right]}{A_{107}^{T_{L_0}} (22.50)}$	0.977	0.969	0.970	0.706	0.672	0.600	0.596	(18)
(19)	$\frac{C_{H.W., (27.60)}^{T_{L_0}}}{V_{R., (27.60)}^{T_{L_0}}} - \frac{V_{H.W., 75}^T}{V_{H.W., 75}^{T_{L_0}}} - \frac{V_{H.W., 49}^T}{V_{R., (27.60)}^{T_{L_0}}}$	- 0.00050	- 0.00023	- 0.00038	+ 0.00027	+ 0.00115	+ 0.00285	+ 0.00062	(19)

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TABLE XV—Continued.

		Lévis Graving Dock.	St. Nicholas.	Point Platon.	Grondines.	St. Jean des Chailions.	Fatiscan.	Champlain.
(20)	$V_{R.W.} \frac{T_{30}}{V_{R.} \left( \frac{27.60}{T_{118}} \right)}$	0.20150	0.24940	0.31520	0.53310	0.63015	0.74465	0.85252
(21)	$E_{H.W.} \frac{T_{30}}{R_{.} (31.20)}$	12.40	13.75	15.85	18.77	20.13	23.40	24.30
(22)	$E_{H.W.} \frac{T_{30}}{R_{.} (36.32)}$	12.59	14.22	16.72	20.80	22.81	26.73	28.22
(23)	$E_{H.W.} \frac{T_{108}}{R_{.} (31.20)}$	20.77	21.96	24.67	26.33	27.49	30.25	31.02
(24)	$E_{H.W.} \frac{T_{108}}{R_{.} (36.32)}$	18.95	19.80	22.20	22.77	23.18	24.90	25.85
(25)	$U_{L.W.} \frac{T_{75}}{V_{L.W.} \left( \frac{21.70}{T_{118}} \right) - V_{L.W.} \frac{T_{49}}{V_{R.} \left( \frac{21.70}{T_{118}} \right)}$	20.28	20.98	22.64	25.60	26.87	29.77	30.68
(26)	$\hat{V}_{L.W.} \frac{T_{30}}{V_{L.W.} \left( \frac{21.70}{T_{118}} \right) - V_{L.W.} \frac{T_{49}}{V_{R.} \left( \frac{21.70}{T_{118}} \right)}$	0.25943	0.32265	0.40213	0.46540	0.51900	0.57800	0.63400
(27)	$\hat{V}_{L.W.} \frac{T_{30}}{V_{L.W.} \left( \frac{21.70}{T_{118}} \right) - V_{L.W.} \frac{T_{49}}{V_{R.} \left( \frac{21.70}{T_{118}} \right)}$	0.34780	0.43516	0.51480	0.58490	0.64240	0.70000	0.75400

(27)	$C_{L, w, \left( \begin{smallmatrix} 167 \\ 10, 46 \end{smallmatrix} \right)} = \frac{V_{L, w, 117}}{V_{L, w, 31, 46}} - \frac{V_{L, w, 46}}{V_{L, w, 31, 46}}$	+0.00111	+0.00457	+0.00010	-0.00062	-0.00078	-0.00001	(27)
(28)	$\frac{V_{L, w, 30}}{V_{L, w, 31, 46}} \text{ for } \begin{smallmatrix} T_{30} \\ T_{118} \end{smallmatrix}$	0.23844	0.60288	0.91610	0.98892	1.00764	1.03016	(28)
(29)	$\frac{V_{L, w, 30}}{V_{L, w, 31, 46}} \text{ for } \begin{smallmatrix} T_{30} \\ T_{118} \end{smallmatrix}$	0.27451	0.65327	0.92510	0.93418	0.93831	0.94438	(29)
(30)	$\frac{V_{L, w, 30}}{V_{L, w, 31, 46}} \text{ for } \begin{smallmatrix} T_{30} \\ T_{118} \end{smallmatrix}$	0.23063	0.60251	0.94070	1.00396	1.04282	1.05358	(30)
(31)	$\frac{V_{L, w, 30}}{V_{L, w, 31, 46}} \text{ for } \begin{smallmatrix} T_{30} \\ T_{118} \end{smallmatrix}$	0.31120	0.70383	0.94660	0.93309	0.96415	1.01266	(31)
(32)	$\frac{V_{L, w, 30}}{V_{L, w, 31, 46}} \text{ for } \begin{smallmatrix} T_{30} \\ T_{118} \end{smallmatrix}$	0.70	2.70	7.17	9.52	13.20	14.30	(32)
(33)	$\frac{V_{L, w, 30}}{V_{L, w, 31, 46}} \text{ for } \begin{smallmatrix} T_{30} \\ T_{118} \end{smallmatrix}$	-0.80	3.75	8.77	11.33	14.60	15.68	(33)
(34)	$\frac{V_{L, w, 30}}{V_{L, w, 31, 46}} \text{ for } \begin{smallmatrix} T_{30} \\ T_{118} \end{smallmatrix}$	0.473	2.128	6.277	8.576	12.200	13.300	(34)
(35)	$\frac{V_{L, w, 30}}{V_{L, w, 31, 46}} \text{ for } \begin{smallmatrix} T_{30} \\ T_{118} \end{smallmatrix}$	-1.066	3.081	7.861	10.376	13.684	14.718	(35)
(36)	$\frac{V_{L, w, 30}}{V_{L, w, 31, 46}} \text{ for } \begin{smallmatrix} T_{30} \\ T_{118} \end{smallmatrix}$	0.028	2.519	6.888	9.228	12.887	13.984	(36)
(37)	$\frac{V_{L, w, 30}}{V_{L, w, 31, 46}} \text{ for } \begin{smallmatrix} T_{30} \\ T_{118} \end{smallmatrix}$	-0.803	3.519	8.486	11.028	14.311	15.376	(37)
(38)	$C_{L, w, \left( \begin{smallmatrix} 49 \\ 10, 46 \end{smallmatrix} \right)} = \frac{V_{L, w, 75}}{V_{L, w, 31, 46}} - \frac{V_{L, w, 49}}{V_{L, w, 31, 46}}$	+0.00127	+0.00181	-0.00065	-0.00150	-0.00131	-0.00031	(38)
(39)	$\frac{V_{L, w, 30}}{V_{L, w, 31, 46}} \text{ for } \begin{smallmatrix} T_{30} \\ T_{118} \end{smallmatrix}$	0.24087	0.61561	0.87735	0.80860	0.92880	0.95587	(39)
(40)	$\frac{V_{L, w, 30}}{V_{L, w, 31, 46}} \text{ for } \begin{smallmatrix} T_{30} \\ T_{118} \end{smallmatrix}$	0.35261	0.67483	0.82005	0.84470	0.88267	0.95167	(40)

TABLE XV.—Continued.

		Lévis Graving Dock.	St. Nicholas.	Pointe Platon.	Grondines.	St. Jean des Chailions.	Batiscan.	Champlain.
(35)	$E_{L, W,}^{T,} \left( \begin{smallmatrix} 30 \\ R, (31.20) \end{smallmatrix} \right) \text{ for } \begin{smallmatrix} T, \\ 118 \end{smallmatrix}$	2.70	4.10	8.00	16.07	18.63	22.45	23.85 (35)
(36)	$E_{L, W,}^{T,} \left( \begin{smallmatrix} 30 \\ R, (36.32) \end{smallmatrix} \right) \text{ for } \begin{smallmatrix} T, \\ 118 \end{smallmatrix}$	1.90	3.90	9.50	16.87	19.03	23.05	24.40 (36)
(37)	$C_{L, W,}^{T,} \left( \begin{smallmatrix} 75 \\ R, (27.80) \end{smallmatrix} \right) - V_{R,}^{T,} \left( \begin{smallmatrix} 21.70 \\ 27.60 \end{smallmatrix} \right) \begin{smallmatrix} T, \\ 40 \end{smallmatrix}$	4.02	5.58	10.76	20.73	23.37	27.38	28.85 (37)
(38)	$V_{L, W,}^{T,} \left( \begin{smallmatrix} 30 \\ R, (21.50) \end{smallmatrix} \right) \text{ for } \begin{smallmatrix} T, \\ 118 \end{smallmatrix}$	3.79	6.12	13.07	21.23	23.48	27.73	29.40 (38)
(39)	$C_{L, W,}^{T,} \left( \begin{smallmatrix} 46 \\ R, (107) \end{smallmatrix} \right) - V_{R,}^{T,} \left( \begin{smallmatrix} 22.60 \\ 31.10 \end{smallmatrix} \right) \begin{smallmatrix} T, \\ 107 \end{smallmatrix}$	0.00061	0.00050	0.00650	0.00272	0.00035	0.00142	0.00054 (39)
(40)	$V_{L, W,}^{T,} \left( \begin{smallmatrix} 30 \\ R, (21.50) \end{smallmatrix} \right) \text{ for } \begin{smallmatrix} T, \\ 118 \end{smallmatrix}$	0.23441	0.35450	0.30850	0.53332	0.70335	0.92498	0.94226 (40)
(41)	$C_{L, W,}^{T,} \left( \begin{smallmatrix} 46 \\ R, (107) \end{smallmatrix} \right) - V_{R,}^{T,} \left( \begin{smallmatrix} 22.60 \\ 31.10 \end{smallmatrix} \right) \begin{smallmatrix} T, \\ 107 \end{smallmatrix}$	0.28723	0.39850	0.88550	0.77296	0.73605	0.79994	0.90295 (41)
(42)	$V_{L, W,}^{T,} \left( \begin{smallmatrix} 30 \\ R, (21.50) \end{smallmatrix} \right) \text{ for } \begin{smallmatrix} T, \\ 118 \end{smallmatrix}$	0.00050	0.00041	0.00398	0.00146	0.00005	0.00120	0.00072 (42)
(43)	$C_{L, W,}^{T,} \left( \begin{smallmatrix} 46 \\ R, (107) \end{smallmatrix} \right) - V_{R,}^{T,} \left( \begin{smallmatrix} 22.60 \\ 31.10 \end{smallmatrix} \right) \begin{smallmatrix} T, \\ 107 \end{smallmatrix}$	0.18000	0.30944	0.25332	0.52204	0.70820	0.88972	0.93164 (43)
(44)	$V_{L, W,}^{T,} \left( \begin{smallmatrix} 30 \\ R, (21.50) \end{smallmatrix} \right) \text{ for } \begin{smallmatrix} T, \\ 118 \end{smallmatrix}$	0.22950	0.34551	0.64378	0.65106	0.71255	0.78120	0.86808 (44)

(41) $V_{A,w},$ $V_{R, (21.50)}$	$\begin{matrix} T. \\ 30 \\ \swarrow \searrow \\ T. \\ 118 \end{matrix}$	0.210250	0.323107	0.500001	0.527104	0.700005	0.706905	0.706657	0.950005	(41)
(42) $E_{A,w},$ $R, (22.10)$	$\begin{matrix} T. \\ 30 \\ \swarrow \searrow \\ T. \\ 118 \end{matrix}$	10.40	10.80	12.45	13.27	13.78	14.77	15.35	(42)	
			17.55	17.80	17.87	18.08	18.45	18.90		
(43) $E_{A,w},$ $R, (21.50)$	$\begin{matrix} T. \\ 30 \\ \swarrow \searrow \\ T. \\ 118 \end{matrix}$	10.274	10.601	12.270	12.953	13.355	14.226	14.788	(43)	
			17.327	17.341	17.443	17.595	17.976	18.387		

Notwithstanding the fact that the loci of the summits and troughs of a series of fluvial undulations occupy, as a rule, higher or lower positions, according as the average coefficient of amplitude corresponding to the said series is greater or smaller, yet in the cases of the Graving Dock, St. Nicholas and Pointe Platon—owing to exceptional perturbations in the normal successions of tide waves Nos. III. and IV.—the low water curves or loci of losing fluvial series No. IV., as approximately drawn on diagram Nos. XVI. XVII. and XVIII. come to occupy, on the whole, more elevated positions than the corresponding curves of gaining series No. III., although the tides forming this last series have a greater importance than those of No. IV., in the ratio of 68 to 65.

Again, during the high water season, the fluvial discharge, seldom if ever, remains uniform sufficiently long to permit of the St. Lawrence assuming a permanent or settled condition, all the way, say from Lake St. Peter or Verchères, to Quebec, which gives rise to many irregular fluctuations on various stretches of the upper portion of the estuary.

For these and other cognate reasons, it became necessary not only to substitute, as indicated in diagrams Nos. VI., VII., VIII., and XVI., XVII. and XVIII., for the original low water lines or loci of the three stations mentioned, viz.: those of the Graving Dock, St. Nicholas and Pointe Platon, amended ones more nearly in accord with the altered conditions of the estuary, when in a quasi permanent or settled state, over its whole length, as regards the effects of the fluvial discharge on the water level; but also to deviate slightly from loci actually determined in other cases, according to the particular circumstances under which these curves were obtained—the whole with a view of arriving at the above proper values of relations Nos. 8, 9, 11 and 12 with the estuary in the settled or permanent condition referred to and corresponding rational water levels.

The results given in the last table I believe to be as accurate as a single year's reliable high and low water gauging will permit of arriving at, there is no doubt, however, that more positive and precise data would be secured if complete series of tidal observations and simultaneous river gaugings, such as those made in 1887–88, were made for several years in succession.

As during the low water season, the fresh water discharge remains often nearly uniform for a week at a time or even longer, the relative positions of the high and low water levels which obtain every year at such time, will generally differ but little from those above determined, especially in calm weather and when the moon is near the equator; but the case is very different at the high water season or at any other time when the fluvial discharge varies rapidly. If the river is rising the slopes will, of course, be, on the whole, steeper and when falling flatter, than that corresponding to a permanent flow; the height of the river at Verchères being the same in the three cases.

The figures in Table XV. indicate, as they should do, that proceeding from Champlain down stream:

1. The change of level which takes place in the estuary per foot of elevation or depression of the river at Verchères, decreases continuously until, at Quebec, it is reduced to from 0.18 ft. to 0.30 ft., according to the state of the tide.

2. The tidal amplitudes and ranges are affected less and less by the fresh water discharge; being reduced during a rise of 10 ft. in the river at Verchères, in round figures, by as much as 0.66 of their first values at Champlain and only by 0.04 at Quebec.

3. At high tide, the level of the water is invariably less affected by variations in the fresh water discharge, than at low tide.

4. The estuary may descend lower at neaps than at springs, as far down as say Ste. Croix, a point between Pointe Platon and St. Nicholas; thence eastward, at low water of springs of maximum importance, the estuary is always drawn down to a lower level than at neaps of minimum importance; the fluvial discharge and height of river at Verchères being supposed to be the same in both cases.

In order to determine the highest point to which the tide water is likely to rise, and the lowest to which it may fall, in ordinary weather, during the season of navigation, we have yet to take into consideration the effects produced in the estuary by the diurnal inequalities of the tide waves. These inequalities are, as well known, greatest along the sea-coast in the tides that are due to the attraction of the sun and moon when

the declination of the latter is a maximum, and the said inequalities disappear in those tides which are believed to be due to the attractions of the same heavenly bodies when the moon crosses the equator. It must be remembered the particular tides here referred to are felt at Quebec, in common with all others, forty-eight hours after the times when the said heavenly bodies occupied the positions to which they (the tides) correspond.

Some idea may be formed of the relative importance of the variations in the water level at the various tide stations due to this cause, by glancing over the following list of maximum inequalities in the high and low water levels, as observed and recorded during the low water season of 1887 and the high water season of 1888.

TABLE XVI.

Tide Stations.	Maximum diurnal tidal differences observed in high water levels.		Maximum diurnal tidal differences observed in low water levels.	
	At low stage of river in 1887. (Series II.)	At high stage of river in 1888. (Series VIII.)	At low stage of river in 1887. (Series II., III. and IV.)	At high stage of river in 1888. (Series V., VI. and VIII.)
	Feet.	Feet.	Feet.	Feet.
Levis Graving Dock..	4.356	3.340	1.450	1.540
Chaudiere.....	4.040	3.260	1.410	1.400
St. Nicholas.....	3.910	3.140	1.390	1.370
Pointe Platon.....	3.606	2.989	1.035	0.995
Grandines.....	2.918	2.420	1.197	0.500
St. Jean des Chaillons.....	2.659	1.930	1.318	0.510
Batiscan.....	2.345	1.266	1.100	0.505
Champlain.....	2.268	0.960	1.150	0.550

The above differences do not, however, represent the true inequalities in the heights of the summits of tide waves of equal astronomical importance above, or the depths of the troughs of such undulations below a mean tide level situated at a sensibly constant elevation. They are alternately too large or too small, owing to (1) the variation in mean importance of every pair of consecutive tides, (2) the rise or fall of the mean tide level in passing from a series of gaining to one of losing tides, or *vice versa*; such differences are also often affected by local disturbances of the normal or regular fluctuations of the estuary, more especially the diurnal low water differences.

The maximum corresponding differences of height in high water and low water levels of series Nos. II. and VIII. of tides, observed in 1887 and 1888, may be assumed to have the following values, after being corrected so as to eliminate approximately, in each case, errors arising from the effects of decreasing or increasing astronomical tides on the general level of the St. Lawrence, and also for any small errors due to rapid fluctuations of the river at Verchères, and to local causes of disturbance of the normal level of the estuary.

TABLE XVII.

Tide Stations.	Corrected maximum diurnal lunar tidal inequalities in high water levels.		Corrected maximum diurnal lunar tidal inequalities in low water levels.	
	At low stage of river in October, 1887.	At high stage of river in May, 1889.	At low stage of river in October, 1887.	At high stage of river in May, 1889.
	(Series II.)	(Series VIII.)	(Series II.)	(Series VIII.)
	Feet.	Feet.	Feet.	Feet.
Lévis Graving Dock.	3.80	2.80	1.55	1.52
Chaudière.	3.55	2.76	1.48	1.45
St. Nicholas.	3.35	2.70	1.40	1.36
Pointe Platon.	3.10	2.50	1.20	1.10
Grondines.	2.50	2.10	0.90	0.65
St. Jean des Chaillons.	2.20	1.65	0.80	0.55
Batiscan.	1.95	1.00	0.73	0.45
Champlain.	1.85	0.75	0.70	0.30

The greatest diurnal differences in the high and low tide levels were found to obtain generally from one day ahead of, to one to three days subsequent to the time when the moon's declination was a maximum.

Being apprehensive that the differences, as above corrected, might prove to be an excessive estimate of the probable normal maximum diurnal inequalities for ordinary high and low water seasons, viz., of the tidal inequalities disassociated from the effects of high winds at sea, sudden changes in the atmospheric pressure, and irregular local variations in the fresh water supply, I computed also the average of the differences which obtained every day at each station, during four consecutive series of gaining and losing tides, so as to take in a whole lunar month in each season.

This permitted of dispensing altogether with the corrections otherwise required as above described, as the excesses in the observed differences of height between the two wave summits and the two wave troughs of a tide day, respectively, over the corresponding tidal inequalities solely due to astronomical causes which arise from a varying mean tide level, the continuous gradual increase or decrease of the mean theoretical importance of the tides and changes in the fresh water discharge, may be considered to be about balanced by corresponding deficiencies; these average differences are as follows:—

TABLE XVIII.

Tide Stations.	Average diurnal differences observed in high water levels.		Average diurnal differences observed in low water levels.	
	At low stage of river during lunar month, Oct. 12 to Nov. 10, 1887.	At high stage of river during lunar month, May 5 to June 3, 1888.	At low stage of river during lunar month, Oct. 12 to Nov. 10, 1887.	At high stage of river during lunar month, May 5 to June 3, 1888.
	Feet.	Feet.	Feet.	Feet.
Lévis Graving Dock.	1.637	1.701	0.460	0.426
Chaudière.	1.416	1.642	0.455	0.362
St. Nicholas.	1.280	1.581	0.440	0.346
Pointe Platon.	1.234	1.546	0.403	0.237
Grondines.	1.014	1.127	0.330	0.170
St. Jean des Chaillons.	0.802	0.910	0.271	0.160
Batiscan.	0.710	0.506	0.214	0.155
Champlain.	0.649	0.390	0.312	0.150

It is evident from these figures that most of the amended maximum differences are much in excess of double the average observed ones, and, perhaps, rather on the large side than otherwise. But as these maximum inequalities obtained in the fall of 1887 and the spring of 1888 under apparently no extraordinary circumstances, it is not improbable that equally large differences may obtain in any year at the low and high stages of the river, respectively 21.50 and 36.32 ft. above datum at Verchères. I have, therefore, concluded, in order to be on the safe side, to place the water line for the reduction of soundings, lower at each station than the mean low tide level corresponding to the lowest neaps—or that of the highest springs where these descend below the neaps—by one-half the corresponding corrected maximum diurnal inequalities as above deduced from the low water gaugings of 1887, instead of only by a depth equal to the average diurnal inequality.

By subtracting one-half the amended maximum low water inequalities from elevations:  $E_{L.W.}$  for  $T_{30}$  and  $E_{L.W.}$  for  $T_{118}$  of the mean low water levels at lowest neaps and highest springs with the river at 21.50 ft. above datum at Verchères, we find the lowest elevations:  $e_{L.W.}$  for  $T_{30}$  and  $e_{L.W.}$  for  $T_{118}$  to which the estuary may descend at each station below Three Rivers, under the ordinary conditions of wind and weather described to be as follows:—

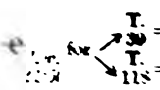
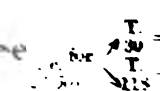
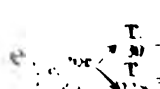
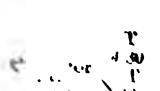
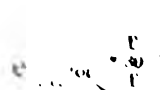

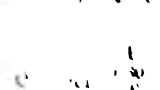
TABLE XIX.

	Lévis Graving Dock.	St. Nicholas.	Pointe Platon.	Grondines	St. Jean Des- chaillons.	Batiscan.	Cham- plain.
	Feet above datum.	Feet above datum.	Feet above datum.	Feet above datum.	Feet above datum.	Feet above datum.	Feet above datum.
$e_{L.W.}$ for $T_{30} = \dots\dots$	— 0.147	+ 0.404	1.919	6.438	8.828	12.522	13.634
$e_{L.W.}$ for $T_{118} = \dots\dots$	— 1.668	— 0.545	2.919	8.036	10.628	13.946	15.026

Taking the diurnal inequalities observed in 1887 and 1888 at the gauging stations above Three Rivers, as a basis of computation, the maximum diurnal inequalities in the elevations of the low tide levels during the low water season at the said stations have been estimated as shown hereunder, and the corresponding elevations of the lowest water at minimum neaps (30) and maximum springs (118), with the river surface 16.0 ft. over sill old lock No. 1, Lachine Canal, or 27.54 ft. above datum at the said lock in both cases, viz. :

$e_{L.W.}$  for  $T_{30}$  and  $e_{L.W.}$  for  $T_{118}$  have also been approximately determined. (See Table XX.)

TABLE XX.

Localities, etc.	Elevation of mean low water, based on the general river level that obtains with series of tides of average importance corresponding say to co-efficient (65).	Estimated excess of the mean weekly elevation of the river, produced by a series of tides of maximum mean importance (85) over the level that obtains with tides of average importance (65).	Estimated fall from mean low to minimum low water level, owing to diurnal and serial tidal inequalities.	Elevation of minimum low water at minimum neaps (30) and maximum springs (118).
	Feet above datum.	Feet.	Feet.	Feet above datum.
Three Rivers 	T. 30 =	16.31	— 0.30	= 16.06
	T. 118 =	16.46	— 0.30	= 17.41
Port St. Francis 	T. 30 =	16.30	— 0.34	= 16.17
	T. 118 =	16.41	— 0.34	= 17.44
Sorel 	T. 30 =	19.00	— 0.30	= 18.85
	T. 118 =	19.20	— 0.30	= 20.08
Outremont 	T. 30 =	19.57	— 0.33	= 19.84
	T. 118 =	20.14	— 0.33	= 20.86
Verchères 	T. 30 =	21.50	— 0.36	= 21.42
	T. 118 =	21.50	— 0.36	= 22.17
Longueuil 	T. 30 =	25.30	— 0.36	= 25.18
	T. 118 =	25.40	— 0.36	= 25.58
Montreal 	T. 30 =	27.54	— 0.30	= 27.54
	T. 118 =	27.64	— 0.30	= 27.73

\* Based on French Canal.

The highest levels that can be counted on being reached at high water at the gauging stations for discharging vessels that are grounded, etc., and the lowest elevations to which the water must rise and below which, therefore, the bed of the estuary is never left uncovered at high tide when the river is at the normal low stage, 21.50 ft. above datum at Verchères—  
 actually over the sea level at low No. 1, Lachine Canal, are arrived  
 tested maximum high water diurnal inequality at each station.

as per table XVII., to the corresponding value of  $E_{h.w.}^{T.}$  for  $\frac{T}{118}$  as per (43) Table No. XV., and deducting the said semi-inequality from  $E_{h.w.}^{T.}$  for  $\frac{T}{30}$ ; the results being as follows :—

TABLE XXI.

	Lévis Graving Dock.	St. Nicholas.	Pointe Platon.	Grondines	St. Jean des Chaillons.	Batiscan.	Cham- plain.
	Feet above datum.	Feet above datum.	Feet above datum.	Feet above datum.	Feet above datum.	Feet above datum.	Feet above datum.
$E_{h.w.}^{T.}$ for $\frac{T}{30}$ — semi-ineq = ..	8.374	8.926	10.720	11.703	12.255	13.251	13.863
$E_{h.w.}^{T.}$ for $\frac{T}{118}$ + semi-ineq = ...	19.195	19.002	18.891	18.693	18.695	18.951	19.312

With a view of arriving at the absolute maximum and minimum elevations of the estuary, at high and low tide respectively, there remain yet to be determined the greatest possible deviations from the mean elevations of the normal low and high tide levels, which are due to diurnal inequalities in the tides, the effects of persistent high easterly and westerly winds and changes in the atmospheric pressure. These effects have to be considered jointly in connection with the diurnal tidal inequalities, there being no means, with the data available, as far as I can make out, for disassociating one kind of disturbance from the other, or either from the diurnal tidal inequalities which arise from the inclination of the plane of the moon's orbit to the celestial equator.

The following is a list of the greatest diurnal differences which obtained at Quebec under varying conditions in 1876 and 1882, according to the tide gauge registers which were kept under my direction during the said years :—

TABLE XXII.

Date.	Elevations of consecutive high-tide levels.	Diurnal differences between high-tide levels.	Elevations of consecutive low-tide levels.	Diurnal differences between low-tide levels.	Remarks.
1876.	Feet above datum.	Feet.	Feet above datum.	Feet.	
Feb 20	10.80 18.10	3.20	1.00 4.20	3.20	Estuary depressed at Quebec to -4.80 ft., the lowest level on record, viz., one day previous to moon crossing equator, after three days of persistent heavy westerly gales; moon full February 25; maximum flood range of 20.90 ft. observed in 1876. Tidal importance corresponding to coefficient 81.
March 4	13.70 16.30	3.20	0.30 0.30	0.00	At quadrature, moon having entered second quarter February 3, viz., one day previous to her declination attaining a maximum. Westerly winds, February 2 to 4.
March 7	13.30 15.10	3.40	1.00 1.30	2.30	After two days' light easterly winds. Moon three-quarter full and about half-way back northward to equator. Maximum tide observed in 1876 = 20.60 ft.
March 10	13.00 14.70	3.40	1.30 1.40	2.20	During north-westerly squalls, about 1½ days after moon entered last quarter, her declination being 28° to 27° south, and near a maximum. Minimum flood range observed in 1876 = 20.20 ft.
March 13	12.80 14.50	3.40	1.30 1.40	2.20	During north-easterly squalls within four days of new moon, and three days previous to her passage to the north of the equator, declination being 28° to 29° south. Minimum tide range observed in 1876 = 20.20 ft.
March 16	12.80 14.50	3.40	1.30 1.40	2.20	Light westerly winds. Moon 22 and 23 after a succession of light squalls. Moon's declination from 12° to 10° south. New moon, March 25.
March 19	12.70 14.40	3.40	1.30 1.40	2.20	Light westerly squalls with moon's north declination maximum. March 24. First quarter, April 1.
March 22	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
March 25	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
March 28	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
March 31	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
April 3	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
April 6	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
April 9	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
April 12	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
April 15	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
April 18	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
April 21	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
April 24	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
April 27	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.
April 30	12.70 14.40	3.40	1.30 1.40	2.20	New moon, April 2. Moon's north declination maximum, April 3.

... inequalities—1. That the ... were ... or ... the ... changes ... are of much

greater importance than those due to the varying attraction of the moon from morning to evening and *vice versa*, when she is at her greatest distance north or south of the equator, that is to say, when her declination is a maximum. 2. That the high tide levels are raised by easterly gales and depressed by westerly ones to a much greater extent than the low tide levels, the maximum daily difference which obtained while the former were blowing, being inclusive of tidal inequalities, 5.90 ft. and with the latter 3.80 ft.

It is true these, the greater of the total diurnal inequalities here referred to, were observed during the winter months of 1876; but we shall see presently that on 5th and 6th November, 1884, the summit of the fluvial wave was elevated even more above its normal height by a north-easterly storm than it was raised or depressed respectively by the most violent and persistent easterly or westerly winds experienced at Quebec, during the winter season of 1876. Furthermore, the trough of the fluvial undulation was also depressed considerably below its normal level on Wednesday, the 7th of November, 1877, yet not so much as on Friday, the 25th of February, 1876.

Being unable to deduce directly from the data available the diurnal inequalities which actually obtained in either the elevations of the high or those of the low water marks of the dates last mentioned, I estimated the effects of the storms, etc.; on the normal high and low water levels, as explained hereunder.

On the 7th of September, 1881, I was informed by the late Woodford Pilkington, Esq., M.I.C.E., who was then resident engineer of the new Quebec Harbour improvements and Lévis Graving Dock, that the lowest water observed by him at Quebec occurred on Wednesday 7th November, 1877, when the estuary sank at low tide to 2 ft. 2 in., or say 2.18 ft. below the 0 of the Quebec Harbour Commissioners' gauge on the south-east side of their Pointe-à-Carcy wharf, which corresponds to an elevation of  $(2.18 + 0.02) = 2.20$  ft. below datum. This great depression of the St. Lawrence estuary was caused by a spring tide wave accompanied by fresh south-westerly winds, the importance of which corresponds to a theoretical tidal coefficient of 94; viz.: one day previous to the moon's S. declination reaching a maximum value equal to  $27^{\circ} 50' 26''$ , and two days after new moon, while the river stood at Sorel about 20ft.-2in. over the zero of the Montreal Harbour Commissioners' gauge of the same place. This height of 20ft.-2in. corresponds to an elevation of  $(20.166 + 0.05) = 20.216$  ft., or say 20.2 ft. above datum, being  $(20.20 - 18.35) = 1.85$  ft. above the extreme low stage of the river when its surface stands 20.85 ft. above datum at Verchères and 15.5 ft. over the sill of lock No. 1 at the foot of the Lachine Canal, and  $(20.20 - 19.00) = 1.2$  ft. above the standard low water which corresponds to a river surface, 21.50 ft. above datum at Verchères and 16.0 ft. over the lock sill just mentioned.

As no tidal observations were made by Mr. Pilkington at night, the very low water level observed by him, Wednesday, 7th November, 1877, probably obtained, say at about 3.10 p.m. and the succeeding high water in the vicinity of 8 p.m. We know moreover, that in October and November the most important spring floods take place in the afternoon or evening, that is to say, in normal conditions as regards wind and weather, the estuary rises to a greater elevation in the evening at high water springs than it does in the forenoon. Under ordinary circumstances the elevation of the 8 o'clock p.m. high water would therefore have been greater than the elevation of the 7.30 a.m. high water on 7th November, 1877. Now the depth of the fluvial wave trough below the mean level of the estuary is always, in a measure, proportional to the height of the tidal intumescence which immediately precedes it above the same level, hence the elevation of the low water of 3.10 p.m. in question must have been greater than that of either of the adjacent low tide levels, viz.: by about 0.4 ft. or 0.5 ft.; judging by the inequalities of some tides that were observed during October and November, 1887, when the weather was comparatively calm and the position of the moon, in reference to the equator, somewhat similar to that occupied by her, 7th November, 1877.

The elevation of one or the other of the low tide levels last mentioned, viz.: the lowest that obtained at new moon in November 1877, was therefore probably as low as  $-(2.2 + 0.4) = -2.6$  ft. if not lower; the river surface being 20.2 ft. above datum at Sorel, and 22.7 ft. at Verchères.

Again, according to the approximate rectilinear locus *a b* of low tide levels shown on diagram No. XVI., the trough of *a* 94 tide descends to nearly—0.60 ft. with a fluvial discharge corresponding to an average water level of 21.80 at Verchères, and according to relation (17) page 132, a variation of 1 foot in this level at the ordinary low fall stage of the St. Lawrence, produces a corresponding change of about 0.27 ft. in the low tide level at Quebec. Hence, for a river level of 22.7 ft. at Verchères the elevation of the normal mean low water level of 7th November, 1877, at Quebec, is found to be equal to : — (0.60 ft. — 0.24 ft.) = — 0.36 ft.; and allowing 0.42 ft. for the diurnal lunar inequality, — 0.57 ft. is arrived at for the elevation of the deepest and — 0.15 ft. below datum for that of the shallowest trough of the waves propagated up the St. Lawrence past Quebec, on the date mentioned, whence the lowering of the estuary on this day at low tide, directly attributable to the prevalence of westerly winds, is deduced to be — (2.2 — 0.15) = 2.05 ft.

I am not in a position to determine in a similar manner, the effects of high winds on the low tide level of the estuary at the low stage of the river in the fall, at points above Quebec. I believe, however, we may assume, in the absence of more precise information and without risk of erring very much either way, that the total depression of the trough of the mean fluvial wave and the total elevation of the crest of the latter due to diurnal lunar tidal inequalities, high winds and changes in the pressure of the atmosphere combined, vary from one station to another, approximately in the same respective ratios, as the corrected maximum diurnal differences which have been deduced for the same stations, from the series of tidal observations made during the low water season of 1887 and during the high water season of 1888. (See Table XVII. of this report.)

Judging by several years of meteorological records I have examined, it does not appear unreasonable to suppose that westerly gales nearly as severe as that experienced in November, 1877, might prevail in the Lower St. Lawrence about the time of neaps as well as at the time of spring tides during the low water season. Hence, the same as for the locus of the lowest troughs of the undulations propagated up the St. Lawrence when the stream is in a normal state with a minimum discharge, the water line of absolute minimum elevation will obtain :

(a.) From Quebec up to a point beyond St. Nicholas and east of Pointe Platon, in the event of a spring tide corresponding to maximum theoretical coefficient 118 and accompanied by violent gales occurring, say towards the end of October (as in October, 1887), about two days after the moon's declination is a maximum; the river proper being at the extreme low stage when the water surface is 20.85 ft. above datum at Verchères.

(b.) At all places to the westward of the point in the vicinity of Pointe Platon just referred to, in the event of a neap tide corresponding to minimum theoretical coefficient 30 and accompanied by heavy westerly gales, occurring also in the fall of the year, some two days after the moon's declination is a maximum; the river being at the minimum elevation of 20.85 ft. at Verchères, which, as already stated, corresponds to elevation 18.35 ft. at Sorel, and to a depth of 15.4 ft. on the sill of old lock No. 1, foot of Lachine Canal.

The probable absolute minimum elevation  $E_{\text{min. l.w. r., (20.85)}}$  for  $\begin{matrix} \nearrow T. \\ 30 \\ \text{and} \\ T. \\ \searrow 118 \end{matrix}$  of the water

level of the estuary at each station up to Three Rivers, corresponding to minimum neaps and maximum springs, has been computed on the above basis, as shown hereunder, with the aid of the elevations of mean low tide, for a mean fluvial level of 20.85 ft. at Verchères at neaps of 30 and springs 118 previously established, viz. :

$E_{\text{l.w. r., (20.85)}}$  for  $\begin{matrix} \nearrow T. \\ 30 \\ \text{and} \\ T. \\ \searrow 118 \end{matrix}$  as per relation No. (31) page 136 and by using the cor-

rected maximum lunar diurnal inequalities contained in Table No. XVII. in connection with neaps as well as springs.

For determining the absolute minimum elevation at Three Rivers and stations to the westward, the data contained in Table XX. were directly utilized.

TABLE XXIII.

						Feet above datum.
Levis Graving Dock.	E min. l. w. for r., (20·85)	T. 30	= 0·473	—	$\frac{1·55}{2} + \frac{2·05 \times 1·55}{1·55}$	= — 2·357
		T. 118	= -1·096	—	$\frac{1·55}{2} + \frac{2·05 \times 1·55}{1·55}$	= — 3·929
St. Nicholas	E min. l. w. for r., (20·85)	T. 30	= 0·897	—	$\frac{1·40}{2} + \frac{2·05 \times 1·40}{1·55}$	= — 1·664
		T. 118	= -0·240	—	$\frac{1·40}{2} + \frac{2·05 \times 1·40}{1·55}$	= — 2·791
Ponte Platon	E min. l. w. for r., (20·85)	T. 30	= 2·128	—	$\frac{1·20}{2} + \frac{2·05 \times 1·20}{1·55}$	= — 0·069
		T. 118	= 3·081	—	$\frac{1·20}{2} + \frac{2·05 \times 1·20}{1·55}$	= + 0·894
Groundnes	E min. l. w. for r., (20·85)	T. 30	= 6·277	—	$\frac{0·90}{2} + \frac{2·05 \times 0·90}{1·55}$	= + 4·637
		T. 118	= 7·861	—	$\frac{0·90}{2} + \frac{2·05 \times 0·90}{1·55}$	= + 6·221
St. Jean des Chailons	E min. l. w. for r., (20·85)	T. 30	= 8·575	—	$\frac{0·80}{2} + \frac{2·05 \times 0·80}{1·55}$	= + 7·117
		T. 118	= 10·376	—	$\frac{0·80}{2} + \frac{2·05 \times 0·80}{1·55}$	= + 8·917
Batiscan	E min. l. w. for r., (20·85)	T. 30	= 12·289	—	$\frac{0·73}{2} + \frac{2·05 \times 0·73}{1·55}$	= + 10·878
		T. 118	= 13·684	—	$\frac{0·73}{2} + \frac{2·05 \times 0·73}{1·55}$	= + 12·353
Champlain	E min. l. w. for r., (20·85)	T. 30	= 13·300	—	$\frac{0·70}{2} + \frac{2·05 \times 0·70}{1·55}$	= + 12·025
		T. 118	= 14·718	—	$\frac{0·70}{2} + \frac{2·05 \times 0·70}{1·55}$	= + 13·443
Doubert's Land ing. Three Rivers	E min. l. w. for r., (20·85)	T. 30	= 16·060	—	$(21·50 - 20·85 = 0·65) + \frac{2·05 \times 0·50}{1·55}$	= + 14·749
		T. 118	= 17·410	—	$(21·50 - 20·85 = 0·65) + \frac{2·05 \times 0·50}{1·55}$	= + 16·099
Port St. Fran- cis	E min. l. w. for r., (20·85)	T. 30	= 16·170	—	$\frac{0·65 + 2·05 \times 0·44}{1·55}$	= + 14·938
		T. 118	= 17·440	—	$\frac{0·65 + 2·05 \times 0·44}{1·55}$	= + 16·208
Sorel	E min. l. w. for r., (20·85)	T. 30	= 18·850	—	$\frac{0·65 + 2·05 \times 0·30}{1·55}$	= + 17·803
		T. 118	= 20·080	—	$\frac{0·65 + 2·05 \times 0·30}{1·55}$	= + 19·033
Castroeur	E min. l. w. for r., (20·85)	T. 30	= 19·840	—	$\frac{0·65 + 2·05 \times 0·26}{1·55}$	= + 18·846
		T. 118	= 24·860	—	$\frac{0·65 + 2·05 \times 0·26}{1·55}$	= + 19·866

TABLE XXIII.—Continued.

					Feet above datum.		
Verchères ....	E min. l. w. for r., (20° 85)	↗	T. 30	=	21·420 —	$0·65 + \frac{2·05 \times 0·16}{1·55}$	= + 20·558
			T. 118	=	22·170° —	$0·65 + \frac{2·05 \times 0·16}{1·55}$	= + 21·308
		↘	T. 30	=	25·180 —	$0·65 + \frac{2·05 \times 0·04}{1·55}$	= + 24·480
			T. 118	=	25·580 —	$0·65 + \frac{2·05 \times 0·04}{1·55}$	= + 24·880
Longueuil ....	E min. l. w. for r., (20° 85)	↗	T. 30	=	27·540 —	$0·58 + \frac{2·05 \times 0·00}{1·55}$	= + 26·960
			T. 118	=	27·740 —	$0·58 + \frac{2·05 \times 0·00}{1·55}$	= + 27·160
		↘	T. 30	=	27·540 —	$0·58 + \frac{2·05 \times 0·00}{1·55}$	= + 26·960
			T. 118	=	27·740 —	$0·58 + \frac{2·05 \times 0·00}{1·55}$	= + 27·160
Montreal, foot of Lachine Canal.	E min. l. w. for r., (20° 85)	↗	T. 30	=	27·540 —	$0·58 + \frac{2·05 \times 0·00}{1·55}$	= + 26·960
			T. 118	=	27·740 —	$0·58 + \frac{2·05 \times 0·00}{1·55}$	= + 27·160
		↘	T. 30	=	27·540 —	$0·58 + \frac{2·05 \times 0·00}{1·55}$	= + 26·960
			T. 118	=	27·740 —	$0·58 + \frac{2·05 \times 0·00}{1·55}$	= + 27·160

The highest tides that have ascended the St. Lawrence, within the recollection of the oldest inhabitants of Quebec city, are the evening tide of Wednesday, 5th November, 1884, and that of the following morning. These tides corresponded to the syzygy of 3rd November at full moon, when she was from 13° to 16° north of the equator; her declination being thus within 5½° to 2½° of its nearest maximum, viz.: 18°–25°, which she reached on Thursday, 6th November, at about 11 a.m. Moreover, the evening tide of 5th November was the most important of the two tides in question, having for theoretical coefficient 108, and the depth on the sill of old lock No. 1, Lachine Canal, was 17·6 ft., which corresponds to a river level of 23·25 ft. nearly above datum at Verchères.

In telegraphic despatches dated Father Point and River du Loup (Fraserville), 5th November, and which were published in the "Quebec Morning Chronicle," 6th November, 1884, it is stated that this storm was considered to be the worst that visited the Lower St. Lawrence during the past 40 years, and that it caused much damage to both public and private property in that part of the Dominion. In the town of Rimouski and vicinity many houses, barns, stables and wharves were damaged; some buildings being driven out to sea with their contents. Total loss estimated at no less than from \$25,000 to \$30,000. (See Appendix No. 16, extracts from "Quebec Morning Chronicle" of 6th November, 1884.)

The following additional particulars appeared in the paper just named, on Friday, 7th November, 1884, under the heading of "The Great Storm."

"The tides were driven up the St. Lawrence estuary by a violent snow storm from the eastward which lasted between two and three days, lashing the waves into fury. The water in the river was raised several feet higher than during the high tides experienced in 1883; in fact it is generally conceded that such high tides have not been seen at Quebec for half a century previously. Much damage was done to property in the lower portions of the city and also some in surrounding villages.

"Dalhousie street was so much flooded that the traffic had to be carried on by skiffs, and in some places the water came up to St. Peter street. Champlain and Finlay market-places were both under water, and all the warehouses in the immediate vicinity were more or less flooded.

"The St. Lawrence washed over all the wharves both on Dalhousie and St. Andrew's streets and the St. Charles overflowed its banks; very considerably flooding not only the village of Hedleyville; but also some of the low streets of St. Rochs.

"At Lévis a number of stores near the river were similarly flooded and a quantity of property was swept from the wharves; a portion of the Intercolonial Ry. wharf was also submerged and damaged."

"At South Quebec, it has been estimated that the evening tide of 5th November surpassed by two feet the very high spring tides of 1883, which caused heavy damages to the Grand Trunk Railway freight sheds, etc.

"Many steamers and schooners had to run into Cap Rouge for shelter; part of this village was inundated, the water having, it is stated, risen four feet above ordinary spring tide high water mark."

Some marks were pointed out to me by four different persons on Champlain and Finlay market-places, Quebec, and at St. Nicholas, indicating the highest levels reached by the tides in question.

These marks were all levelled to and their elevations calculated; but the results do not turn out to be as concordant as might be desired. The elevations range from 21.82 ft. at St. Nicholas up to 24.14 ft. above datum at Quebec, and it looks as if in some cases the morning high water mark of 6th November was indicated, and in others that of the preceding tide, viz.: the evening tide of 5th November.

In any case I think the elevation, 24.14 ft., of a point on the floor of Mr. Louis Bourget's grocery, on Finlay market square, at the corner of Laplace street, up to which, I was informed by Mr. J.-Bte. Caron, head clerk, the water rose in November, 1884; having been observed by himself through a knot hole in the flooring, may be accepted as a reliable and correct indication of the height actually reached by the evening tide of 5th November, 1884.

According to the locus AB of the normal mean high water levels of series of gaining tides No. VII., observed at Quebec in the spring of 1888—while the river stood at an average height of 31.50 ft. above datum at Verchères—which is shown on diagram No. XVI., the elevation of the summit of a spring tide the importance of which corresponds to an astronomical coefficient of 108, is: 18.90 ft., and for a river level of 23.25 ft. at Verchères this wave summit would, under ordinary circumstances, stand:  $18.90 - (31.50 - 23.25) \times 0.18 =$  say, 17.40 ft. over datum.

As the moon passed from the southern to the northern hemisphere, at about 6.0 a.m., 31st October, the high water diurnal inequalities resulting from the difference between her action at the upper meridian passage and that at the lower passage, must have been comparatively small on 3rd November following, certainly less than the average value of 1.636 ft., made out for the low water season of 1887, probably not over 1.0 foot. If now we deduct 17.40 ft., the mean normal high water elevation of a 108 spring tide, with a river surface 23.25 ft. above datum at Verchères, from the actual height reached by the crest of the fluvial wave, Wednesday evening, diminished by one-half, such portion of the excess in the height of the said evening tide over that of either of the adjacent morning tides, as may be directly attributed to the diurnal variations in the action of the moon, viz.: 0.5 from 24.14 leaving 23.64 ft., we arrive at  $6\frac{1}{4}$  ft. for the approximate elevation of the tide wave at Quebec by the violent north-easterly storm of 5th November, 1884.

The average depth on the lower sill of the St. Ours lock was 10.4 ft. on the 5th and 6th November, and the elevation of the water surface 23.06 ft. above datum; hence, if we allow 0.36 ft. for the fall of the Richelieu from the lock to Sorel, 22.70 ft. is arrived at for the elevation of the St. Lawrence at this town on Thursday, 6th November. On the other hand the depth on the sill of lock No. 1, Lachine Canal, at Montreal, was 17.6 ft., and the elevation of the water surface 29.04 ft., which corresponds, under ordinary circumstances, to a mean river level of 20.75 ft. nearly at Sorel, instead of 22.70 ft. This goes to show that the St. Lawrence was gradually raised at least to the extent of  $22.70 - 20.75 = 1.95$  ft. at Sorel and vicinity, by the successive unusually high tides which obtained from about 2nd to 7th November, 1884.

We have seen that the greatest known effects of both westerly and easterly winds on the water level at Quebec during the season of navigation, obtained in the fall of the year, near the time of spring tides and when the river was comparatively low and the fresh water discharge small. Also, the summit of the fluvial wave invariably attains its greatest elevation in the entire maritime portion of the St. Lawrence, near the time of springs, and, as before stated, the ratio of the greatest rise in the high tide level of any place that can be caused by easterly winds, to the corresponding corrected maximum diurnal inequality due to the action of the moon, as given in Table XVII., may be assumed to be approximately the same for all tide stations above Quebec. In view, therefore, of the fact that, as far as known, the river level fluctuates at Verchères between the extreme limits of 20.85 and 36.32 ft. above datum, or 15.47 ft., and about  $15.47 \times 0.9 = 13.9$  ft. at Champlain and  $(15.47 \times .2) = 3.1$  ft. at Quebec, while the proba-

ble maximum effects of the easterly storms at the same places, are on an average only, say :  $\left( \frac{1.85 + 0.75}{3.80 + 2.80} \times 6.25 \right) = 1.6$  ft. and  $6\frac{1}{2}$  ft. respectively, where 1.85 and 0.75 and 3.80 and 2.80 represent the corrected maximum diurnal inequalities during the low and high water seasons at Champlain and Quebec respectively, as per Table No. XVII., it is evident that the estuary will attain its greatest elevation possible, in the event of a spring tide of the greatest amplitude possible in May or the beginning of June, viz.: one the theoretical coefficient of which is, for the reasons above stated, equal to 108, occurring within the time just mentioned, about two days after the moon's declination being a maximum and accompanied by a furious easterly wind, such as that experienced in November 1884 ; the river being at the same time swollen to the extreme high level of 36.32 ft. over datum at Verchères.

Assuming that the maximum lunar diurnal tidal inequalities coincide approximately with those entered in Table XVII. for the high water season of 1888, and taking relations Nos. (4), (19), (20), (23) and (24), pages 130 to 134, as a basis of computation, I have arrived, as follows, at the elevation  $E_{\text{max. H.W.}}$  of absolute maximum high water on the R., (36.32)

estuary of the St. Lawrence above Quebec : 1°. with the atmosphere in a normal state, 2°. with a low barometer and violent easterly storms.

TABLE XXIV.

Tide Gauging Stations.	Mean $E_{\text{H.W. 108, R., (36.32)}}$ with atmosphere in a normal state.	Corrected maximum semi-diurnal inequality. (See Table XVII.)	$E_{\text{max. H.W. 108, R., (36.32)}}$ with atmosphere in a normal state.	Rise caused by violent easterly storms.	$E_{\text{max. H.W. 108, R., (36.32)}}$ with violent easterly storms and a low barometer.
	Feet above datum.	Feet.	Feet above datum.	Feet.	Feet above datum.
Lévis Graving Dock.	20.280 +	1.40	= 21.680 +	6.25	= 27.93
St. Nicholas .....	20.980 +	1.35	= 22.330 +	$\frac{6.25 \times 2.7}{2.8}$	= 28.35
Pointe Platon .....	22.640 +	1.25	= 23.890 +	$\frac{6.25 \times 2.5}{2.8}$	= 29.47
Grondines .. .....	25.600 +	1.05	= 26.650 +	$\frac{6.25 \times 2.1}{2.8}$	= 31.34
St. Jean des Chaillons	26.866 +	0.825	= 27.691 +	$\frac{6.25 \times 1.65}{2.8}$	= 31.37
Batiscan .. .....	29.770 +	0.500	= 30.270 +	$\frac{6.25 \times 1.0}{2.8}$	= 32.50
Champlain .....	30.583 +	0.375	= 30.960 +	$\frac{6.25 \times 0.75}{2.8}$	= 32.63

For Three Rivers and the gauging stations to the westward, the corresponding elevations of the highest possible water during the season of navigation as just defined, have been established as shown hereunder, viz.: upon the same principle as was adopted for determining : (a) the extreme high tide levels at Three Rivers and Port St. Francis

that would obtain if a spring tide, of the maximum importance of 118, occurred while the river stands at its highest known stage of 36.32 ft. at Verchères, (b) the extreme low water levels corresponding to a mean river level 20.85 ft. above datum at Verchères, with allowance for effect of persistent westerly winds at all the gauging stations between Three Rivers and Montreal.

Decreased fall due to increase of 2 in theoretical tidal coefficient from 106 to 108 :

$$(a) \text{ Sorel to Port St. Francis} = 1.10 - \left\{ \frac{(1.10 - 0.98)(108 - 106)}{106 - 46} = 0.004 \right\} = 1.096 \text{ ft.}$$

$$(b) \text{ Sorel to Three Rivers} = 1.95 - \left\{ \frac{(1.95 - 1.75)(108 - 106)}{106 - 46} = 0.007 \right\} = 1.943 \text{ ft.}$$

Again, fall as further modified by swelling of river from 22.30 ft. and 31.30 ft. above datum to elevation 36.32 ft. at Verchères :

$$(a) \text{ Sorel to Port St. Francis} = 1.54 - \left\{ \frac{(1.54 - 1.096)(36.32 - 22.30)}{31.30 - 22.30} = 0.69 \right\} = 0.85.$$

$$(b) \text{ Sorel to Three Rivers} = 1.54 + \left\{ \frac{(1.94 - 1.54)(36.32 - 22.30)}{31.30 - 22.30} = 0.62 \right\} = 2.16.$$

Therefore, with the river proper at the highest possible stage, as far as known, and a tide the amplitude of which corresponds to astronomical coefficient 108, we have for the elevation of the mean tide level :

$$(a) \text{ At Port St. Francis: } 34.07 - 0.85 = 33.22.$$

$$(b) \text{ At Three Rivers: } 34.07 - 2.16 = 31.91.$$

Now, we have seen (page 121) that when the river is at its highest stage, the amplitude of the highest springs is reduced to 0.29 ft. at Three Rivers. Taking 0.28 ft. for the amplitude of a tide of 108, as against 0.29 ft. for one having an importance of 118, and assuming as heretofore, that the effect of the wind on the water level varies from place to place, approximately, in the same ratio as the corresponding diurnal inequalities, we find the elevation of the absolute maximum high tide level at Three Rivers to be :

$$E_{\text{max., H.W.,}} = 31.91 + \frac{0.28}{2} + \frac{6.25 \times 0.50}{2.80} = 33.22 \text{ ft. above datum.}$$

R., (36.32)

and the corresponding low tide level :

$$E_{\text{max., L.W.,}} = 31.91 - \frac{0.28}{2} + \frac{6.25 \times 0.50}{2.80} = 32.94 \text{ ft. above datum.}$$

R., (36.32)

In the vicinity of Port St. Francis, as already explained, the tidal intumescence becomes practically obliterated at the extreme high stage of the river under consideration ; but the effects of the easterly storms continue to be appreciable, so that by using the estimated diurnal inequalities entered in Table XX, we can put approximately :

		Feet above datum.
$E_{\text{max. H.W.}}$ R., (36.32)	At Port St. Francis. ....	$33.22 + \frac{6.25 \times 0.44}{2.80} = 34.20$
	At Sorel. ....	$34.07 + \frac{6.25 \times 0.30}{2.80} = 34.73$
	At Contrecoeur. ....	$35.17 + \frac{6.25 \times 0.26}{2.80} = 35.75$
	At Verchères. ....	$36.32 + \frac{6.25 \times 0.16}{2.80} = 36.68$
	At Longueuil. ....	$40.02 + \frac{6.25 \times 0.04}{2.80} = 40.11$
	At Montreal, foot of Lachine Canal	$40.22 + 6.25 + 0.02 = 40.27$

It must be noted, however, that the local effects of the storm between Quebec and Montreal have been left out of consideration ; in such localities as Ste. Croix Bay and Lake St. Peter, where the fetch is considerable, the rise of the high water curve going westward, would, no doubt, be somewhat greater than that indicated by the above elevations, as the river would be depressed more at the eastern end and raised more at the western end of the lake or bay.

#### THE WINTER AND SPRING FLOOD LEVELS, &c.

Occasionally, before the ice bridge at Quebec is sufficiently weakened by the rays of the sun and the currents, or broken up by winds, &c., to move away, and while the river is yet bedecked by an icy crust for miles to the westward of the ancient capital—when near the time of a syzygy, a high fluvial wave is driven up the estuary by a strong north-easterly gale—the tide water rises abnormally high opposite and in the vicinity of the said city, the same as during the open season, lifting the superincumbent ice crust above the top of the wharves, which become covered with ice and are submerged to the depth of several inches.

This happened notably on Sunday, the 30th of March, 1873, two days after new moon, when the morning tide, which had a theoretical importance corresponding to coefficient 1.12, reached an elevation of about 21.4 ft., above datum ; passing some 8 inches over the Finlay market square and flooding many cellars in various parts of lower town and St. Roch's. (See Appendix No. 16.)

On Friday, 8th May, 1874, viz., near the time of neap tides, the ice bridge at Quebec, which had been partly broken up directly opposite the city by some ferry steamers anxious to resume their regular service, departed suddenly *en bloc* ; the key at the narrow gorge immediately above the mouth of the River Chaudière, having given way under the pressure of the freshet waters from above.

As a result of this majestic raising of the ice blockade, many steamers and other vessels in winter quarters were either damaged, sunk or capsized by destructive ice jams and shoves. (See Appendix No. 18.)

No damage appears to have been done directly by the water, and there is no record of the departure of the ice bridge at Quebec, being attended by similar severe shoving and jamming of the ice in any other year.

In the year 1836 an unusually thick and solid ice bridge moved off, also only on the 8th of May ; but no damage was done to either vessels or wharf or other property. (See Appendix No. 17.)

Although considerable damage is sometimes done to public and private property during the season of navigation at Quebec, Lévis and surrounding parishes, by very high tides forced up the estuary past this city by north-easterly storms, late in the fall, as in November, 1884, or early in the spring, as in March, 1873, the losses resulting from the submersion of wharves, markets, streets, sewers, cellars, etc., by these extraordinary fluvial tide waves, cannot be compared to the disastrous consequences of the much-dreaded winter and spring floods which are experienced along one or more longer or shorter stretches of the St. Lawrence, and of some of its affluents, between the foot of the Lachine Rapids and the narrow gorge immediately above the Chaudière River, some 8 miles west of Quebec city.

It has been remarked by old inhabitants of parishes between Quebec and Montreal, which are injuriously affected by abnormal fluctuations of the river level, that from the beginning of the present century up to about 1850 or 1860 disastrous floods were comparatively of rare occurrence, but that since that time, as more and more of the bush lands in the valleys of the upper St. Lawrence and tributaries, and around the great lakes, came to be cleared and better drained, high and destructive floods were experienced at shorter and shorter intervals, until, within the last decade or so, no two or three years could pass by without a rise in the fluvial waters, and an inundation taking place in one locality or another between the said cities.

Whatever degree of importance one may feel inclined to attach to statements of this nature, in reference to the floods which occur at the time when the streams are

swollen by the melting snow and ice, I do not see how they can have any weight in the case of floods taking place in midwinter or at the taking of the ice.

These extraordinary and destructive accumulations of fresh water in particular parts of the bed of the St. Lawrence River and estuary during the winter and in the spring, variable in extent and as regards disastrous consequences, according to the manner of formation of the ice crust late in the fall, and the more or less effective blocking of the waterway at contracted points, around islands and over shoals, are caused: (1) during general and decided thaws, by sheets of ice detached by winds, etc., from the foreshores; (2) in severe frosty weather, by fraeis and anchor ice closely packed under the said upper icy crust, and (3) at the time of the débâcle, by jams or shoves of heavy cakes and fields of hummock ice.

The exceptionally great destruction of property of all kinds, and interruption of traffic caused by the very high floods of 1885 and 1886 in the lower portions of the city of Montreal and neighbouring towns and villages, led to the appointment by the Dominion Government, in June, 1886, of a Commission of Civil Engineers, who were instructed to inquire into the causes of the frequent recurrence of such disastrous inundations and to devise the best means of affording relief in the future. The Commissioners submitted, under date of 15th April, 1888 (*vide* No. 88159), a full report on their investigations, stating the conclusions arrived at by them, the outcome of which has been the construction of embankments or dykes of crib and earthworks along the river front at Montreal, and the erection of pump houses and installation of powerful pumps, etc., the whole with a view of affording protection to the low-lying portions of the city against further damage by flooding.

This report has been printed in *extenso* in the official report of the Honourable the Minister of Public Works for the fiscal year 1889-90.

Here follow, in chronological order, the heights above the mean level of the sea, of characteristic high river and other levels, that have been observed and recorded, or established at Montreal, from the earliest days of the foundation of the city up to the present time, together with explanations and particulars relative to the nature and duration of the floods and the winter and spring fluctuations of the St. Lawrence above Lake St. Peter, the whole, as far as could be made out by the Flood Commissioners of 1886, from an examination of old historical documents, files of newspapers and parliamentary and other official reports:—

TABLE XXV.

Year.		Elevation of river in feet above mean sea level.
1643.....	First great winter rise of St. Lawrence recorded in Montreal, viz.: at Christmas, when white men first wintered here under Maisonneuve, who was driven out of his cantonments by the rising stream.....	Unknown.
1701 or thereabouts.....	Water covered the whole of the lower part of St. Paul street.....	do
1771-1800.....	Lower floors of Grey Nuns' Convent inundated to a great depth. Exact date not recorded.....	do
1798-1810.....	Timber floated over Grey Nun street.....	do
1838.....	*Flood of 14 days' duration in January, 1838, described in <i>Montreal Gazette</i> as being the highest known since 1787. Also highest winter flood at Montreal, 1838 to 1887.....	52 12
1838 1840.....	.....	49 62
1841.....	January flood.....	51 62
1848.....	Flood of five days' duration in January. River level of January greater than any.....	51 00
1852.....	January maximum river level.....	49 87
1852.....	March 11th—Lowest level to which river has risen at the departure of the ice, in 36 years, 1852 to 1887.....	41 04

\*The term "flood" is applied by the Flood Commissioners of 1886-88, to all river levels exceeding 41 feet above the mean level of the sea, which is the elevation of the cut stone revetment wall along Bonquet's street, completed in 1841.

TABLE XXV.—*Continued.*

Year.		Feet of river above mean
1861	April flood water surface at noon; 3rd highest spring flood known	
1865	April flood water surface at noon; 4th highest spring flood on record	
1869	April flood water surface at noon; 6th highest spring flood	
1873	January 6th—Lowest level known at which ice took at Montreal during the shove and jam period.	
1873	April flood, 7th highest spring flood	
1884	January	
1884	April	
1885	April flood, 5th highest spring flood	
1886	January—Highest level reached by river at taking of ice in 35 years, 1852 to 1886.	
1886	April flood water surface, Sunday 18th at 10.50 a.m.; highest spring flood at Montreal in 35 years, 1852 to 1886.	
1887	April flood; 2nd highest spring flood at Montreal.	

From the report of the Flood Commission it appears:

1. That in 1886 the covering over of the St. Lawrence by an icy crust reaching shore to shore, commenced in the vicinity of Nicolet, lower end of Lake St. Pierre, 4th December, viz.: about the time of spring tides, say at 10 a.m.

2. That the upward extension of this crust to Montreal is governed by the forward flow of ice, the supply of which is dependent on the weather, but not every proportionate to it, because more is drawn under the crust or bridge where it is and less where it is thick or the current weak.

3. That the river was completely frozen over from the lower end of Lake St. Lawrence to the foot of the Lachine rapids before an ice bridge commenced to form below the lake, which occurred on the 2nd of February at Pointe Platon, whence the bridge tended westward until a junction was effected, 13th February, with that at Nicolet, Port St. Francis, viz.: near the point where the ice first took, 4th December, 1885.

4. That in addition to the gradual rise of the water simultaneously with the ice in the "bordages," and as the stream becomes filled with floating ice, a special and temporary rise of fluctuation takes place in the river level as the ice bridge advances forward, and that within a short time after the ice has taken and the bridge is permanently established from point to point the water falls about 2 ft.

In the following table will be found the rate of progress of the ice bridge westward and the variations of the winter and spring levels in reference to summer levels, according to the observations and measurements made under the direction of the Commission in connection with corresponding mean summer and winter elevations of the St. Lawrence above the mean level of the sea, surface declivities, etc.—as computed by the Commission.

The effects of the "taking of the ice in the River St. Lawrence during the years 1886-87" on the water levels, are described at length in Appendix No. 6 to the Commissioners' Report, which is also contained in the printed Official Report of the Minister of Public Works for the fiscal year 1889-90.





It will be seen from a close inspection of the above figures, table XXVI. and those of tables XI. and XVIII. in connection with the diagram showing the Flood Commissioners' winter gaugings of 1886-87 at their proper elevations above the mean level of the sea, which is submitted herewith (Ill. No. XXIII.)\*, that while in summer and during the open season generally, the slope of the river between Montreal, Sorel and Nicolet is quite flat and very gradual, and remains nearly uniform within a range of several feet above and below the mean summer level: from the instant the stream commences to freeze over, up to the end of the débâcle, the conditions of flow are continually changing and the surface declivities anything but gradual or uniform, for any length of time.

The Flood Commissioners have established: 1. That in the early part of winter, frais is packed in immense quantities—252,601,000 cubic yards to 476,212,000 cubic yards of water, between the Lachine Rapids and Varennes—more or less closely under the upper crust of solid or field ice. 2. That the unceasing variations in the hydraulic regimen of the stream, just referred to, arise from the tendency of the portions of this frais which are most exposed to be displaced by the actions of the currents, to become distributed on the waterway in such a manner as to permit of the volume of water carried by the river in winter, passing out of the estuary with the least expenditure of energy and loss of head possible under the circumstances.

Thus, while during the formation of an ice bridge from Nicolet to Laprairie, 4th to 30th December, 1886, the resistance  $h$  to the passage of the winter discharge from Montreal to Nicolet was, at first, as great as the pressure exerted by a water column 26.06 ft. high: on the 17th of January, 1887, or 18 days after the complete freezing over of the river between the places first mentioned,  $h$  had been reduced to 21.04 ft. of water pressure.

Furthermore, 27th March, or 43 days after the complete closing up of the stream from Platon to Nicolet, viz: between 4th and 12th February, which produced a rise of over 5 ft. at the place last mentioned at the foot Lake St. Peter,  $h$  was only 15.87 ft. at

Montreal; the head of resistance having thus been reduced by  $\frac{26.06 - 15.87}{26.06} = 0.39$  of its first value.

Again, during the same space of time, 43 days, a corresponding reduction of  $\left(\frac{4.82 - 2.55}{4.82}\right) h = 0.47 h$  obtained at Sorel; and at Verchères one of  $\frac{13.44 - 7.74}{13.44} = 0.42$  of the value of  $h$  at the taking of the ice at this place.

Although between the 2nd and 4th periods mentioned at the head of the last statement (No. XXVI),  $h$  was diminished by from 30 to 45 per cent or more, or say, on an average, 40 per cent of its value at the taking of the ice on 27th March, 1887, this resistance was still in excess of the head due to friction on the bed, etc., in the open stream down to Nicolet: 60 per cent at Montreal, 62 per cent, at Verchères and 24 per cent at Sorel. Were it not that on account of the freezing over of the estuary as far down as Quebec, its general or mean level is raised and the average cross section of the tidal stream considerably enlarged, as also that of the long stretch of river situated beyond the direct influence of the tides now under consideration, the said average increase of 40 per cent in the resistance  $h$  would not form more than one-fifth part of that due to the practical doubling of the wetted perimeter  $p$ , which is effected when either a natural or an artificial waterway, of very great width as compared to its depth, is covered over.

We know that in general, for a stretch of river on which the motion is uniform or nearly so, the following relation holds good, viz.:

$$h = \tau \frac{lp}{F} \frac{v^2}{2g} = \tau \frac{lp}{F} \left( \frac{Q^2}{F^3} \right) = \tau \frac{lp}{2g} \frac{Q^2}{F^3} \quad (1)$$

\* Ill. No. XXIII.—Reproduced  $\frac{1}{2}$  full size by lithography—to accompany Official Report of Minister of Public Works for fiscal year 1890-91.

where :

$h$ , represents the resistance of friction, or the friction head,

$\zeta$ , a coefficient of friction variable with the velocity,

$l$ , the length of the stretch of river considered,

$p$ , the wetted perimeter,

$v$ , the velocity, say in feet per second,

$F$ , the area of the cross section of the stream, say in square feet,

$g$ , the acceleration of gravity, which is taken at 32.02 ft. per second, on an average.

$Q$ , the rate of discharge, say in cubic feet per second.

And when a large stream like the St. Lawrence is covered over by an ice crust, we may put with sufficient accuracy for present purposes :

$$h' = \zeta' \frac{2lp}{F'} \frac{v^2}{2g} = \zeta' \frac{2lp}{2g} \frac{Q'^2}{F'^3} \quad (2)$$

Taking as a basis of computation, eight cross sections as uniformly distributed as practicable, along the stretch of river between Longueuil and Sorel, among those which were sounded in the winter of 1886-87 under the direction of the Montreal Flood Commission, viz :  $\overline{AB}$  at Longueuil with 98,000 square ft. of water ;  $\overline{IJ}$  at a point midway between Longueuil and Longue Pointe, containing 99,000 square ft. ;  $\overline{RZ'}$  at Longue Pointe, 105,500 square ft. ;  $\overline{CD}$ ,  $\overline{IJ}$  at Pointe aux Trembles, 169,000 square ft. ;  $\overline{CD}$  at Repentigny, 182,000 ;  $\overline{EF}$ ,  $\overline{HG}$  at Verchères, 163,000 ;  $\overline{AB}$  at Lanoraie, 105,000. and  $\overline{CD}$ ,  $\overline{EF}$ ,  $\overline{FG}$ ,  $\overline{HI}$  at Sorel, containing 217,500 square ft. of water. (See Ill. No. XXVII.) I find the average areas of the clear waterway and of the frasis to have been as follows, between Longueuil and Sorel during the 1st and 4th periods, viz. :—

	Sq. ft.
1. Clear waterway with the river at mean summer level, corresponding to a depth of 19 ft. on the sill of lock No. 1, and, say, to 22.50 ft. per Montreal Harbour Commissioners' gauge at Sorel.....	119,000
2. Clear waterway, with river at level of 27th March, 1887.....	140,500
3. Frasis.....	29,000

Again, according to the measurement of the discharge of the St. Lawrence, which was made at Lanoraie, 2nd and 3rd November, 1886, viz. : about the time of neap tides, when, it is stated, there was 11 ft. 9 in. on the flats of Lake St. Peter, which corresponds to water level 20.75 ft. above zero of the Montreal Harbour Commissioners' Sorel gauge, and 20.80 ft. above datum : (1.) The area of the mean cross section was  $F = 115,000$  sq. ft. (2.) The surface width  $b = 34.60$  ft. (3.) The mean depth  $d = 33.25$  ft. And (4.) The mean velocity  $v_{r., (28.80)} = 2.7391$  ft. per second, the mean velocity  $v_{r., (22.55)}$  of the river, at the mean summer level of, say, 22.55 ft. above datum at Sorel may be taken

approximately at :  $v_{r., (22.55)} = v_{r., (20.80)} \left( 1 + \frac{22.55 - 20.80}{2d} \right) = 2.8112$  ft. per second for which  $\zeta = 0.0795$ .

Also, from gaugings made during winter and summer, in connection with the projected Cedars Canal, at Cedars village—a point on the Cedar Rapids where the river is open all the year around for 5 miles on either side, and its elevation but little affected by irregular winter fluctuations of Lakes St. Francis and St. Louis, excepting those due to high winds—it appears that in winter the water does not fall much below its minimum elevation during the open season, and for a considerable part of the time stands at a higher level. Moreover, the depths on the sill of lock No. 14, at the head of the Beauharnois Canal, appear, on the whole, to afford a fair approximate indication of the open water fluctuations and corresponding discharges of the St. Lawrence in the locality in question.

Considering that the guard lock (No. 5) at the upper end of the Lachine Canal is also situated at the head of a stretch of river, with rapids several miles long that remain open the whole year round, it is presumed that the depths on the sill of this lock afford an equally fair approximate indication of the winter discharge of the St. Lawrence at Lachine

Now, the depth on the sill of lock No. 5 varied from 1st December, 1886, to 10th April, 1887, between 10'-7" and 12'-7"; the averages for December, January, February, March being respectively: 11'-8", 11'-7", 11'-9" and 11'-5", and the general averages between the dates just mentioned, 11'-6"; moreover, between the 20th of March and the 6th of April, the depth varied only 3 in., viz., from 11'-0" to 11'-3", with an average of 11'1". Also, according to measurements made by the lockmasters in July, 1888, at locks Nos. 1 and 5, the average depths were at the said locks, respectively, 19'-0" and 11'-8" nearly, so that we can assume that on 27th March, 1887, the discharge corresponded to a water level 7 to 8 inches, or say 1.0 ft., below the mean summer level.

But at the mean summer level of  $(62.71 + 11.67) = 74.38$  ft. above datum at lock No. 5, the mean depth of the River St. Lawrence at the head of the upper entrance of the Lachine Canal is, according to the plan of Lake St. Louis, etc., prepared by Mr. E. Lafleur, C.E., in 1887, from actual survey: 17.95 ft., and we may use here for the determination of  $Q'$ , without risk of erring materially, the relation:

$$\frac{\dot{a} - a}{a} = \frac{\frac{3}{2} (Q' - Q)}{Q} \quad (3)$$

where  $a$  denotes the depth at mean summer level and  $\dot{a}$  the reduced depth which obtained 27th March, 1887, whence we deduce:

$$Q' = \frac{2\dot{a} + a}{3a} = \frac{2 \times 17.35 + 17.95}{3 \times 17.95} Q = 0.978 Q, \text{ and } \frac{Q'}{Q} = 0.978.$$

Finally putting  $\zeta' = \zeta = 0.0795$ , on account of the small difference between  $\dot{v}$  in summer, and  $\dot{v}$ , March, 1887, substituting in equations (1) and (2) the numerical values of  $F$ ,  $F'$ ,  $\zeta$ ,  $\zeta'$  and  $\frac{Q'}{Q}$ , just found for the symbols, we arrive at:

$$\frac{h'}{h} = \frac{\left\{ \zeta' / 2 p Q'^2 \right\} \left\{ 2 g F^3 \right\}}{\left\{ \zeta / 2 p Q^2 \right\} \left\{ 2 g F'^3 \right\}} = 2 (0.978)^2 \left( \frac{119.000}{140.500} \right)^3 = 1.1623.$$

The ratio which actually obtained 27th March, 1887, on the reach from Longueuil to Sorel is, as per above Table XXVI.:  $\frac{14.24 - 2.55}{8.14 - 1.94} = \frac{11.69}{6.20} = 1.885$ . Therefore, even at this late date (27th March) of the closed season, after the water had gone down at Longueuil from 42.19 ft. to 38.74 ft. above datum or 3.45 ft., and risen at Sorel from 24.22 to 27.05 = 2.83 ft., viz.: so as to cause a diminution in the actual fall of 6.28 ft., there was still a head of back water of  $(1.885 - 1.162) \times 6.20 = 4.48$  ft., directly attributable to the obstruction of the river bed by frasis; nay, a head probably exceeding 4.48 ft., for, no allowance whatever was made for covering the relative decrease in the volume of water flowing over the rapids at a fixed stage of the river when it is obstructed by ice.

Such being the case, after the natural distribution of the frasis in the waterway to the best advantage, as regards the flow of the water seaward, had been going on for a month and a half from the complete closing up of the river, 12th February, down to Platon and further, it can well be understood how even a moderately rapid increase in the volume of water carried by the St. Lawrence during winter, under ordinary circumstances, may be the sole cause (exclusive of ice jams) of a head being raised in the vicinity of Montreal city, sufficiently great for the swollen stream to flood the low-lying quarters of the said city, together with those of the neighbouring towns and villages, as well as some portions of the roads and fields on both shores, before a passage of the requisite discharging power can be worked through the stream, when surcharged with frasis, to permit of the free and regular outflow of the increased affluence of water.

TABLE XXVII.

FLOOD levels established between Lachine and Quebec, with notes relative to the damages done by the floods, the causes of the same, etc., the nature of the marks levelled to, etc., etc., the whole according to information obtained in the localities visited, from the municipal authorities and other sources.

## NORTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Town of Lachine. Lock No. 5, head of Lachine Canal. (County of Jacques-Cartier).	173·5	.....	.....	.....	.....	.....	Depth on lock-sill, measured every day at noon by lock-master. River open during the whole winter in 1886-87. Average depth on lock-sill from 28th December, 1886, when river became frozen over from shore to shore up to 10th April, 1887, when swelling of stream by spring freshets commenced; = 11'-7", which corresponds to an elevation of 74·30 ft. above datum.
Lot No. 4669, Parish of Montreal. Jos. Brault, owner.	165·3	.....	.....	.....	57·93	58·26	Highest flood water of 1886 came to top of lower entrance steps, Jos. Brault's stone residence. Top of fence rail flush with highest water, April flood of 1887.
St. Henri pump-house.	163·9	.....	.....	.....	56·90	58·45	Marks in engine room pointed out by Alex. Baby, assistant to Alex. Fiset, engineer in charge of St. Henri water-works pumping machinery.
Lock No. 1, Lachine Canal. (City of Montreal).	161·5	52·29	48·96	52·20	55·79	54·67	Depth of water on lock-sill, measured regularly every day at noon by lock-master. Average depth on sill, 28th December, 1886, when river was completely frozen over, to 10th April, 1887, when swelling of stream by spring freshets commenced, = 29·8", which corresponds to an elevation of 41·21 ft. above datum.
Thibeau deau Bros. & Co.'s store, Commissioners' street. (City of Montreal).	161·0	.....	.....	.....	55·96	55·39	Lines indicating highest flood levels of 1886 and 1887, painted in black on cut stone store front.
Longue Pointe. (Co. of Hochelaga).	154·7	.....	.....	46·60	.....	45·03	Boat tied to verandah of H. Lapointe Esq., in 1885. Flood marks of 1885-87 on ground at foot of verandah, and at foot of tree pointed out by Mrs. Lapointe, (See notes, &c., by Mayor Lapointe, Appendix No. 20.)
Pointe aux Trembles. (Co. of Hochelaga).	151·0	.....	.....	.....	.....	.....	Mr. Achille Beaudry, Mayor of Pointe aux Trembles, called on Tuesday, 14th Aug., 1888, states that he gave instructions to Mr. Jeannotte, the clerk of the municipality, to make observations and marks asked for by department in April, 1887; but that Mr. Jeannotte had changed his place of residence without leaving any record of what he had done.
Repentigny. (County of L'Assomption).	144·0	.....	.....	.....	42·92	.....	1886. Flood mark on Secretary-treasurer F. X. O'Brien's shed on concession road to River L'Assomption. (See notes, &c., by M. O'Brien, Appendix No. 20.)
do	143·3	42·08	.....	42·29	42·66	.....	1886. Mark underside of entrance step, front of Mayor Eusèbe Juneau's store dwelling. Flood level of 1865 observed by Mr. Benjamin Rivet, who noted the height of the water in reference to the sash bars dividing the small panes of glass in his windows. Water remained high 7 to 8 days in 1885, and only about 5 to 6 in 1886. In the spring of 1885,

TABLE XXVII.—*Continued.*

FLOOD levels established between Lachine and Quebec, etc.

## NORTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Repentigny—(Con.)							River L'Assomption was completely blocked by ice and its waters forced to discharge themselves laterally through gullies into the St. Lawrence; some houses were demolished, or rather came down on account of being undermined. Ice is often piled up very high in the spring opposite MML. Juneau and Rivet's houses, and these are occasionally threatened with destruction by ice-shoves.
Lavaltrie. (Co. of Joliette.)	130.8				*43.86 42.60	42.02	Flood marks made in 1886-87 by Denis Giguère, light-keeper, on trees near the Lavaltrie wharf. (See notes and observations respecting flood of 1887, etc., by Dr. Sin. Martineau, Mayor of Lavaltrie, Appendix No. 20.) *Water remained at elevation 43.86 only for a couple of hours; but for several days at about 42.60. Both Dr. Martineau and D. Giguère state that since the opening of the new south channel and the deposition of dredgings between the north and south channels and on the foreshores by the Montreal Harbour Commissioners, the ice is all drawn towards the south shore in the spring. The current strikes this south shore nearly at right angles and helps the piling up of ice on the battures. A proof that the whole of the water is drawn towards the said shore is, they state, that no slabs or chips or other mill refuse from Repentigny or the Ottawa River comes ashore in the vicinity of Lavaltrie, as previous to the opening of the second channel.
Lamoraie—lower end of parish. (Co. of Joliette.)	122.0			35.72	42.22	36.78	Flood levels pointed out by Mr. Louis Coderre, of Lamoraie—1885 mark, a high spot on ground in yard. In 1886, a mark was made with a knife on the jamb of a door in the wall between the main house and the kitchen annex; water remained some two days near this mark, which is 3.32 feet above the kitchen floor. 1887 mark, a spot on the ground at the foot of the entrance steps to the kitchen. Mr. Coderre says the flood of 1865 did not rise as high as that of 1886, opposite his land.
Lamoraie—mouth of River St. Joseph de Lamoraie. (Co. of Joliette.)	120.0			36.47	39.08	36.47	Flood levels pointed out by Edward Valois, farmer, who had charge of Seigneur Bortwick Dauthrie concession grist mill. In 1884 and 1887 water covered the top of a flat stone. Flood of 1886 rose up to top of third clapboard at base of mill, where water remained a day and a night. This flood was caused by an extensive ice jam, which blocked the waterway from above L. Coderre's farm to Antoine Trempe's farm, below which the river stood only 36.27 feet above datum; a shed opposite

TABLE XXVII.—*Continued.*  
 FLOOD levels established between Lachine and Quebec, etc.  
 NORTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Lanoraie—mouth of River St. Joseph de Lanoraie.—(Con.)							the mill helped to bring about an ice jam here. Mr. Antoine Trempe, 68 years old, owner of the first farm in the parish of Berthier going eastward, says he never saw ice piled up opposite his place as it was in 1885 and 1886. Batture ice got stuck in the fall at the head of "Ile aux Poirs" and "Ile St. Ignace," whence it reached across to Sorel, and during winter the main channel, as well as the small northern channel, was blocked by drift ice. According to Mr. Trempe, the flood of 1865 was some 3.0 feet higher than those of 1885 and 1886; the former being caused by the blocking up of the Richelieu Rapid and high N.E. winds. Immediately below this farm the water fell suddenly in 1886, otherwise Berthierville would have suffered heavily.
Lanoraie Village	124.5						Mayor Antoine Caisse called on Wednesday, 15th August. Mr. Caisse states he received no circular or letter from the department and made no flood marks, etc.
Berthierville (County of Berthier.)	116.5				34.57		1886 flood reached top of entrance step, Grand Central Hotel, level indicated by Mr. Beaulne, the proprietor.
		36.37				35.54	Notch made on fence post by F. O. Lamarche, Esq., Mayor of Berthierville, at highest point reached by spring flood of 1887. (See notes, etc., by Mr. Lamarche, Appendix No. 20.) Flood of 1865 10' higher than that of 1887; the highest point being reached by water, 12th April, Wednesday in holy week. Wind blew from the S.E. Tuesday evening, but turned to the northward on Wednesday morning, which cooled the atmosphere to such an extent as to cause fresh ice to take on the "battures"; wind then turned suddenly to the southward, and at 3 p.m. blew a hurricane. At 6 p.m. wind S.W., and at midnight again nearly due north. Battures of ice detached by this strong wind blocked up the river at Richelieu Rapid, causing an unprecedented sudden great rise in the water. The rise, however, fell rapidly, being already some 2 ft. lower on 13th than on 12th, and by the 18th of April the stream had again reached its ordinary summer level. Rev. Mr. Vincent Plinguet, vicar forain and parish priest of Ile du Pas, has written a pamphlet giving a vivid description of the events of 1865, at the time of the great flood, when, it is stated, some 50 or more persons lost their lives by drowning in the islands at the head of Lake St. Peter and vicinity, and many dwellings, barns and stables were carried away, with all their contents,

TABLE XXVII.—Continued.

FLOOD levels established between Lachine and Quebec, etc.

## NORTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Berthierville—(Con.)							horses, cattle, produce, etc. Appendix No. 91 contains copious extracts from Quebec, Sorel and Montreal papers, containing full accounts of this unprecedentedly disastrous and widespread inundation, and of the harrowing and heartrending scenes which accompanied the same, etc., viz. Extracts taken, 1st, from <i>L'Echo de Richelieu</i> and <i>La Gazette de Sorel</i> , as reproduced by <i>Le Canadien</i> (Quebec), 17th April, 1865; 2nd, from <i>La Minerve</i> (Montreal), of 11th, 12th, 13th, 15th, 17th, 18th and 21st April, 1865; 3rd, from the <i>Quebec Morning Chronicle</i> of 12th, 17th, 19th, 20th and 27th April, 1865.
							According to Mr. Sylvestre, M.P.P., the whole of the water passed in April, 1887, through the Ile du Pas channel, which was comparatively clear of ice, while the minor or south channel, and the Berthier, or north channel, were badly blocked up. Attempts were made, 16th and 17th Aug., to visit several of the islands at the head of Lake St. Peter, with a view of calling on Rev. Mr. Plante, and on L. Plante, Esq., Mayor of Ile du Pas, who resides on Ile Madame, 3½ miles east of parish church, but the weather was so bad, the wind so high, and the means of communication so uncertain, that the expedition had to be abandoned, as it became evident that it would take more time than I calculated could then be devoted to it.
St. Barthélemy..... Rang nord. (Lower end of Berthier, or north channel.) (Berthier County.)	109·5	36·85			36·22	35·54	On the 30th of April, 1887, water came up to under side of ash-pan on stove in Louis Gervais' house, east side of concession road leading to St. Barthélemy church. Water remained in Mr. Gervais' house for three or four days in May 1887. It flows into the dwelling every three or four years, and in 1886 it had not all left on the 10th of May.
Maskinongé..... (Maskinongé Co.)	107·0						Mayor Ovide Fleury called on Saturday, 18th August, 1888. Mark made by Mr. Fleury on a tree on his farm indicating flood level of 1887, about 4 miles from St. Lawrence. Elevation of this mark not established on account of large amount of extra levelling required along River Maskinongé, etc., which was not considered warranted by the circumstances.
Louiseville..... (Lower end of River du Loup en haut) (Maskinongé Co.)	100·5				35·26	35·52	In compliance with departmental request of 26th April, 1887, Henry Mineau, Esq., banker, Mayor of Louiseville, made flood marks on bridge over Grande Rivière du Loup and on D. Caron's store house. Having found these marks to be rather far up from Lake St. Peter for establishing their elevations by means of the above lake level, Mr. Mineau advised me to

TABLE XXVII.—*Continued.*

Flood levels established between Lachine and Quebec, etc.

## NORTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Louiseville—( <i>Can.</i> )							call on H. Vadeboncoeur, who resides in last house going southward on west side of Grande Rivière du Loup and keeps a record of most of the high spring floods, &c. Flood levels of 1886 and 1887 marked by Mr. Honoré Chabrier dit Vadeboncoeur at south-east corner of his barn. Mr. Vadeboncoeur's dwelling, barn, shed and stable were carried away with all their contents by the great spring floods of 1865. Loss estimated at \$2,500.
Yamachiche..... (St. Maurice Co.)	94.0						Yamachiche visited Monday, 20th August, and Mayor Th. Dufresne called on, but found that he had this day absented himself, not to return for a whole week. No one else able to point out satisfactorily the flood marks made by him (see his letter to Secretary Public Works, Appendix No. 20). Interviewed Mr. Olivier Lesieur, who acted for many years as agent of the Richelieu Company. Mr. Lesieur states that none of the floods of 1885, 1886 and 1887 proved disastrous at Yamachiche, but that the great flood of 1865, which was accompanied by high south-west wind, swept everything before it at lower Yamachiche. When an ice bridge is formed near Batiscan previous to the ice taking at or below the Richelieu Rapid, the parishes above are, to a great extent, saved from a destructive spring flood.
Pointe du Lac..... (Upper end of parish.) (St. Maurice Co.)	89.5	38.46				33.83	Flood mark of 1865 in Zéphirin Dupont's house, viz.: On small draught door in box stove. Flood level of 1887 pointed out by Onésime Dupont on crest of bank. Lake stated to have been lower in 1886 than in 1887, and to have remained very high some 10 days each year.
Pointe du Lac..... (Lower end of parish, at Mayor Philippe Alarie's farm, 1½ to 2 miles below church.) (St. Maurice Co.)	86.7	39.16				34.78	Mayor Ph. Alarie marked highest water level of 1887 on a tree. He stated that in the spring of 1886 the river did not rise quite as high as in 1887. Mr. Pierre Alarie, the father of the mayor, gives the following particulars relative to the great and destructive flood of April, 1865. On Tuesday evening, 11th April, the wind, which had been blowing from the southward during the day, turned round to the north-west, the weather becoming at the same time very cold. Early Wednesday morning the river was comparatively low, but the water rose so rapidly during a few hours in the forenoon that at about twelve o'clock it was 10 in. deep on a high ridge situated to the southward of Mr. Alarie's house, which depth was sufficient to permit of an empty "bateau" passing over freely. Early in the afternoon a south-west gale sprung

TABLE XXVII.—Continued.

FLOOD levels established between Lachine and Quebec, etc.

NORTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Pointe du Lac—(Con.)							up, and from 3.30 to 6.30 p.m. the wind blew with such force as to cause a further rise of from 2 to 2½ ft. in the St. Lawrence, the water having reached the under side of the stone sill of the door of Mr. Alarie's baking oven. The oven is still standing, and the elevation of its stone sill as well as that of the point on the ridge over which the boat passed have been established. The great flood of 1865 has been caused by a big ice jam near Grondines. The ice took in November, 1864, after a heavy fall of snow, and it is the opinion of many that the waterway was already partly obstructed by ice at Grondines in the fall, for the water stood very high in the early part of the winter. Mr. Madore Paquin, of Pointe du Lac, who keeps a register of all important events in the parish, puts down 12th April for the date of the highest water in 1865. He says, moreover, that in 1798 there was a flood nearly as high as that of 1865, viz.: Within 1 ft. of the height of the latter.
City of Three Rivers.	79 0	36 30	33 40	33 60	30 80	33 46	Flood levels of 1882-83, '84, '85, '86 and '87, observed under the supervision of Thos. Berlinguet, Esq., Engineer Three Rivers Harbour Commission, on a gauge spiked to the corporation wharf. When first put up in 1882, the zero of this gauge corresponded with the very low water originally observed by me 19th September, 1891, when the tides corresponded nearly to the action of the moon when in quadrature, and the river stood nearly 19 30 ft. above datum at Sorel and 15 10" over sill of lock No. 1, Lachine Canal; but both wharf and gauge afterwards subsided about 0 6 ft., and in August, 1888, the said zero was found to be 16 0 ft. above datum. Elevations of April floods of 1882 and 1883 approximately 29 50 ft. and 32 00 ft. F. X. DeBellefeuille, Esq., President Three Rivers Harbour Commission, states that water rose twice on to his floor since 1865; in this last named year he believes at least 2 ft. higher than in 1887. In 1887, river remained near flood height during from 6 to 7 days. The highest point reached by the flood waters of 1865 marked by the late Auguste Martel, Esq., on a lamp post erected at the N.W. corner of De la Fosse and Fleuve streets. Flood level marks of several other years have been added on the same post by Mr. Felix Fleury, who has lived in Mr. Martel's house since 1871. Elevation of mark for 1873, 34 60 ft.; elevations of two marks for years not remembered by him, 34 12 and 33 49 ft. Further particulars relative to damage

TABLE XXVII.—*Continued.*  
 FLOOD levels established between Lachine and Quebec, etc.  
 NORTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
City of Three Rivers. ( <i>Con.</i> )							done, etc., at Three Rivers and vicinity by the great flood of 1865, contained in Appendix No. 19.
Cap de la Magdeleine (Champlain Co.)	76.4				32.52	33.21	Flood mark of 1887, top of small hillock, said to have been covered by six inches water, by the Rev. Mr. Duguay. Highest spring water of 1886 stated to have been from 6 to 9 inches lower than that of 1887.
Champlain Village.. (Champlain Co.)	67.4					32.78	Highest flood water of 1887 marked April 24th, by Xavier Bourbeau, Esq., Mayor of Champlain, on root house built on slope of hill in rear of convent. (See the Mayor's letter to the Deputy Minister of Public Works, dated 28th April, 1887—Appendix No. 20.)
Champlain..... (Bridge on post road over Champlain River.) (Champlain Co.)	64.0	34.76		31.76			Flood levels of 1865 and 1867 marked on N. W. corner of Alphonse Turcotte's former blacksmith's shop, standing on S.W. side of River Champlain. Flood mark for 1885, a spot on the ground covered by 3 inches of water, pointed out by Mr. Arthur Turcotte. Elevation reached by flood waters of 1867, 33.72 feet above datum. Mayor Bourbeau states there is little or no damage done by spring floods in the parish of Champlain; the banks of the St. Lawrence being sufficiently high to prevent the lands from being overflowed.
Batiscan Village.... (Champlain Co.)	59.5	34.73		31.78		31.53	Flood of 1885 rose nearly 9 inches over floor of residence of Jos. Marchildon, Esq., merchant and agent Richelieu and Ontario Navigation Company. Spring flood of 1887 reached top of floor in T. Laquerre's hotel, and in 1885 this floor was covered by 3 inches of water.
Ste. Anne la Pérade, one mile below parish church. (Champlain Co.)	55.0	33.51	31.51				Four spring floods rose over floor of Mr. Théophile Lanouette's house (built in 1717) viz.: in 1865, 2' 1½"; in 1868, 1' 7½"; in 1873, 8½"; and 1884, 1½". Elevation of flood level of 1868 33.01 ft. above datum. In 1865, water entered Mr. Lanouette's residence on Sunday, April 9th, and left it again on the following Wednesday.
							Mr. Ludger Jolin, Mayor of Ste. Anne la Pérade, called on 5th October, 1887. Flood level marked by him in the spring of 1887, considered to be too far up the River Ste. Anne to indicate correct water level of St. Lawrence.
Grondines, 1½ mile above Grande Pointe des Grondines, ¾ mile above the parish church. (Portneuf County.)	51.2					25.06	Flood level of 1887 marked by Mr. Aimé Dolbec on elm tree in his field, at request of Mayor Onesime Rivard, who was asked by Department to attend to this matter. (See his letter dated 25th April, 1887, Appendix No. 20.) Flood of 1873, which is the highest experienced in this locality after that of 1865, rose 8 to 9 inches over a stone or boulder pointed out by Mr. Dolbec having reached an elevation of

TABLE XXVII.—*Continued.*  
 FLOOD levels established between Lachine and Quebec, etc.  
 NORTH SHORE, RIVER ST. LAWRENCE.

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		1865.	1884.	1885.	1886.	1887.	
Grondines—(Con.)							33 53 ft. above datum. In the spring of 1873, Dr. Mayrand and M. G. Hardy rowed from Grondines Village to Ste. Anne la Pêrade in a canoe, following the post road most of the way; they also passed through the window of the old church near the wharf at Grondines Village. In 1865, all the large trees along the river front of Mr. Dolbec's farm were mowed down by ice with the exception of two or three. It is stated that the flood of 1865 was higher at Ste. Anne and Upper Grondines than any other spring flood known in these localities, because ice got jammed and stuck fast above Grande Pointe at Grondines Village and vicinity. The spring flood waters rose higher in 1873 than in 1865, because they were retained by a jam at Pointe Platon. The inhabitants above Grande Pointe, Upper Grondines, have every year to be upon the alert at the time of the débâcle, for fear that the water of the St. Lawrence, forced out of its natural channel over the low lying ground on the north shore, might drown their cattle in the stables. When unusually high floods occur the cattle are taken to the upland, or rather on top of the hill which runs here parallel to the St. Lawrence, and kept there until the water has subsided sufficiently to bring them back to the stables; the cattle have had to remain out in the cold for as long as eight days, in 1873. The fences on the low lying lands have to be taken down every fall, otherwise they are carried away by the flood waters; these also cut up and wash away the earth in many places. Mark made by Mr. Joseph Guibault, April 27th, 1888, at 10 a.m., indicating the highest water of the season on a small tree opposite Anse des Grondines and immediately above Grande Pointe des Grondines and the "Poirniers," two spurs of Grande Pointe. Elevation of this mark = 27 23 ft. Mr. Eugene Grondines, aged 64 years, a member of the numerous family after which this place has been named, relates that before his time, his father who died in 1888, 92 years old, and his uncle went one Sunday to the old church near the wharf in a canoe which they tied to the communion railing.
Grondines wharf (Portneuf County.)	47 0						24 39 In April, 1873, Mr. E. Grondines measured the depth of water, when at its highest, over a stone at the door of the old mill, say $\frac{1}{2}$ mile above the wharf, and found it to be 4 0 ft. Elevation of water corresponding to this depth = 33 89 ft.

TABLE XXVII.—*Continued.*

FLOOD levels established between Lachine and Quebec, etc.

## NORTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Grondines wharf ( <i>Con.</i> )							Stakes planted by Treffé Arcand in 1887 and 1888, with top flush with highest water in the spring. In 1888, river reached its maximum elevation, viz.: 24·95 ft., 28th April, at about 6 a.m., and remained near this level all day. Ice commenced to move at Grondines in 1888, 27th April, at about 9 p.m.; but shortly stopped again when the channel became blocked up and remained so up to 29th, between 1 a.m. and 4 a.m. The waterway got chocked up with ice down to a point a short distance below the wharf, and ice shoved towards north shore after channel got blocked, rising on top of wharf 7 to 8 ft. in height. Ice piled up 20 ft. high, on shoal off wharf, where it remained for over a week. This is not the usual way the ice works opposite the wharf; generally it sticks at Grande Pointe des Grondines, where it partly dams the waterway before any move takes place opposite the wharf.
Deschambault, $\frac{1}{4}$ to $\frac{1}{2}$ mile below parish church. (Portneuf County.)	39·7					22·22	River not very high in either the spring of 1887 or that of 1888. Elevation of highest water observed by Mr. O. Portelance in the spring of 1888 nearly the same as in 1887, viz.: 22·2 ft.; variations of river level appeared nearly as regular as in summer.
			28·34		27·04		Heights of spring floods of 1865, 1873 and 1886 pointed out by Mr. Jean Matte in his house, situated about $\frac{1}{4}$ mile below the wharf. Elevation of flood in 1873 = 27·94 ft. Mr. and Madame Matte state the water remained very high: in 1865 8 days, in 1873 5 days and in 1886 3 days. In 1865 the flood waters put out the fire in the stove.
Portneuf Village. (Portneuf County.)	37·0	27·14	26·60				Highest spring flood levels of 1865 and 1884 pointed out by Madame Veuve Pierre N. Morissette and Onésime Poliquin in their houses. Elevations of corresponding marks nearly the same in both places. Flood of 1865 reached to top of knobs of chest of drawers in Mrs. Morissette's house and to centre of fire door of stove in Madame Poliquin's residence. Flood water of 1884 touched bottom of drawer in first house and took in half the foot of the stove in the second house mentioned. Water has risen several times in the spring up to underside of floor at Mrs. Morissette's and often enters her outhouse. Mayor Camille Poliquin called on 29th August, 1888. Mr. Poliquin says no mark was made by him at the highest spring level of the St. Lawrence in 1887, as requested by department, because ice was shoved up so much higher on land

TABLE XXVII.—*Continued.*

Flood levels established between Lachine and Quebec, etc.

## NORTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Portneuf Village (Con.)							than the water reached that he found it impossible to make a mark on a fixed object that would permit of determining satisfactorily the elevation of the water surface later on. Samuel Labranche, ferryman, says that in 1887 there was only thin or soft, snowy-like frasis in the channel, which did not affect the channel currents very much, either as regards strength or direction. It requires, he says, floating fields of upturned batture ice to cause a regular blockade accompanied by a flood.
Cap Santé (Portneuf County.)	33.0						Locality visited 30th August. No water marks made here, there being no damage done by spring floods; river banks high and steep. At F. Richard's tannery the water covered the road several times in the spring, forcing the vehicles to pass close to the base of the hill for a short distance above this establishment, but no damage was done either to buildings or any other property. Mr. Charles Falardeau and other observant inhabitants of the parish of Cap Santé state that generally an ice bridge is formed at the contracted part of the St. Lawrence, opposite the mouth of the River Chaudière, 8 miles above Quebec city, by reason of large fields of batture ice of considerable thickness which have become detached by north-easterly winds from foreshores above Cap Santé, pivoting around this cape and making their way unbroken towards the said narrow gauge where they block the waterway from shore to shore. It is believed that some ice breakers built on the chains of rocks at Cap Santé and vicinity would have the effect of breaking up the large fields of batture ice into small pieces, by which means the formation of a solid ice bridge 30 to 40 ft. thick or more at the Chaudière pass would be prevented. In such case not only would the St. Lawrence above Quebec be opened to navigation a fortnight to three weeks earlier in the spring than at present, but the chief cause of the most disastrous of the spring floods would also be removed.
Pontre aux Trembles Village (en bas). (Portneuf County.)	21.6		26.46				In the spring of 1884, highest water rose to within 0.3 feet of under side of stone lintel over chimney opening in Gaspard Beland's old house. Beland says ice was piled up high on Trembles shoal near the place of the red buoy, and there was a big jam in the river bed thence towards St. Nicholas; he does not remember ever having seen the water rise so high before. The river remained very high for about a week. Upper portion of Pointe aux

TABLE XXVII.—*Continued.*  
 FLOOD levels established between Lachine and Quebec, &c.  
 NORTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Pointe aux Trembles Village (en bas) (Can.)							Trembles wharf carried away by ice and water. Instead of making a mark at the highest flood level which obtained in April, 1887, Mayor Fortunat Belleau having placed a wrong construction on the request made by the department, instructed the Secretary-treasurer, Mr. Octave Delisle, to observe and register the elevation of the high water level of the estuary on the third day, after full moon following the last new moon, in May, 1887, about which time, it has been observed, the tide usually rises higher at Pointe aux Trembles than at any other time in the spring of the year, probably because the fresh water discharge of the St. Lawrence is then near a maximum. In accordance with this instruction, high water was observed by Mr. Delisle on Tuesday, the 7th of June. No unusual rise of the river observed at the débacle of 1887, or that of 1888.
St. Augustin (Les Fonds) (Portneuf County.)	13 8 26 21 25 40						In 1884 spring flood rose to within 3 inches of under side of second entrance step, and in 1885 to a point 9 7 feet below top of floor in Mr. George Juneau's house. In the former year the river commenced to submerge the grounds around this house on Monday morning 21st April, and receded on the following Saturday afternoon; having thus prevented free access to Mr. Juneau's premises from the roadway for about six days. Fifteen loads of stone, drift wood, &c., had to be carted away after the water subsided. In the year 1843 or 1844, when the late Geo. Juneau, sen., acquired his farm, the water also rose very high in the spring, and some damage was done by floods in several other years besides those specially mentioned. Mr. Philippe McCarthy, whose farm is adjacent to that of G. Juneau on the eastern side, says, that for the past thirty years or more, whenever a spring flood was experienced in this vicinity there was always a solid ice bridge at the "Sault," viz.: opposite the mouth of the River Chaudière. In 1865 the river kept up to or near flood level for about five days; as usual it was the solid key ice bridge at the "Sault" which caused the whole trouble. At the time of the débacle, tremendous ice jams and shoves often take place, from a point one mile or so above Juneau's farm down past the site of the old church, 1 1/2 miles below it: east of this point the jamming and upturning of ice diminishes gradually. Opposite Pierre Gagnon's house at the foot of the hill, on the road to Cap Rouge Village, the ice crust, although less

TABLE XXVII.—*Continued.*  
 FLOOD levels established between Lachine and Quebec, etc.  
 NORTH SHORE, RIVER ST. LAWRENCE—*Concluded.*

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
St. Augustin Con.							broken up than further up stream, is yet generally so much disturbed as to prevent the opening of a good winter road to St. Nicholas on the south shore. It is stated that the flood of 1843-44 rose here higher, if anything than that of 1865. River not extraordinarily high here in 1884; at the débacle, ice generally shoves towards the south shore.
Cap Rouge Village. (Quebec County.)	9.2						Mr. Joseph Daurais, an old resident of the place, says that the water never causes any damage here in the spring, when the river does not rise as high as during high tides in May, and in the fall of the year with north-easterly gales. Ice is broken up where it grounds, and also passes over some wharves, but water does not rise excessively high, at least it does not appear to have ever been stemmed back to any great extent, even when the ice bridge at the "Sault" is of very great thickness and the floating lumps of ice jammed in between the two shores, so as to partly block up the contracted waterway below Cap Rouge.
Quebec Harbour (Quebec West.)	0.0						No inconvenience experienced here at any time from the rise of the estuary caused by the débacle in the spring. Waterway always ample for the free passage of the whole of the ice and water from the Upper St. Lawrence, that has to find its way to the sea. On 11th May, 1874, considerable damage was, however, done, under exceptional circumstances, to shipping in winter quarters at Blais booms, Diamond harbour, &c. In the said year, contrary to the usual course of events, the ice from Lake St. Peter and other points on the upper portion of the St. Lawrence estuary, &c., made its way down stream before the ice bridge at Quebec, which was exceptionally thick and sound, became sufficiently weakened by tidal currents and the action of the sun, to be broken up by high spring tides and winds, in consequence of which heavy jamming and shoving took place in the localities mentioned, and elsewhere in Quebec Harbour, some of the floating masses of ice having to pass under the solid crust and others being forced on top of it and on to the foreshores. Damage done estimated at from $\frac{1}{2}$ to 1 million dollars. (See extracts from Quebec "Morning Chronicle" and "Canadien," Appendix No. 18.) A somewhat similar débacle occurred in the spring of 1836, when the river became completely free of ice at Quebec only about the 10th of May. No damage appears, however, to have resulted from this tardy breaking up of the ice bridge. (See extracts from Quebec "Mercury," May 5th and 10th, 1836, Appendix No. 17.)

TABLE XXVII.—*Continued.*

FLOOD levels established between Lachine and Quebec, etc.

## SOUTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods according to local information.					Remarks.
		1863.	1884.	1885.	1886.	1887.	
Parish of Laprairie, (Ct. of Laprairie) River St. Régis— mouth of river near foot of Lachine Rapids, opposite Lot No. 629, Theo- phile Beauvais Lot No. 619, Ed- mond Bourassa.	168 167 9				61 01 58 84		Points on bank, west side St. Régis River, reached by flood waters in the spring of 1886 and that of 1887 levelled to. Mrs. Edmond Bourassa pointed out a spot on the river bank opposite her house, up to which water reached in 1886. Flood level of 1887 stated to have been nearly 2 0 feet lower than that of 1886 level to.
Lot No. 617, Pierre Goyette.	167 8				58 28		Flood waters of 1886 rose to the top of door in Mr. P. Goyette's residence.
Lot No. 606, Ed- mond Barbeau.	167 2				57 82		Mark made on stake by E. Barbeau, at highest level reached by spring flood of 1886.
Lot No. 555, Adolphe Ste Marie.	166 3				56 16		Mark made by Adolphe Ste. Marie on his barn, at level of highest water, spring of 1886.
Lot No. 554, Judge Pagnuelo.	166 3				56 02 56 32		Flood level of 1886 marked by the occupants of His Honor Judge Pagnuelo's cut stone residence, on wire gauze screen on cellar window, north-east side of house. Mark on the same screen left by water, after it receded in the spring of 1887, 1 7 feet below flood level of 1886.
Parish of Laprairie, Upper St. Lawrence, west of mouth.	166 0				56 38 56 40		Elevation of flood mark made on ice pier in spring of 1887, by Dr. Brisson, at request of department, 56 38 ft. Elevation of flood mark of 1887, made on Joseph Lacharme's blacksmith shop, close to the corner, 56 38 ft. See Dr. Brisson's report, dated April 28, 1887, Appendix No. 20.
Old St. John's River, George's River, and Chicoutimi rivers unite.	165 8			57 00	56 21 56 40		Highest levels reached by spring floods of 1885, 1886 and 1887, marked with a knife on main bar of Montreal hotel, by the proprietor, Mr. Léandre Robert.
Lot No. 514, Naveau Perrat.	164 2				57 04		Flood of 1886 reached to the foot of a white stone, pointed out by Madame N. Perrat.
Lot No. 418, Perron.	163 6				56 84		Spot in ground, pointed out by Mr. Perron, at which spring flood rose in 1886, when at its highest.
Lot No. 311, Louis Roy.	163 3				57 25		Water mark made by Louis Roy, on a willow tree on his ground, in the spring of 1886.
Parish of Laprairie, Chicoutimi River, Lot No. 309, Charles Roy.	163 1				57 20		Water mark painted by P. Roy, at highest flood level of 1886, at the south-west corner of his house.
Lot No. 284, Louis David.	162 4				57 28		Flood level of 1886, marked by L. David on his barn.
Lot No. 284, M. J. M. Trudeau.	162 3				56 01		Spot in ground, reached by spring flood of 1887, pointed out by M. J. M. Trudeau, at the south-west corner of his house. This place is close to Victoria Bridge.

TABLE XXVII.—*Continued.*

FLOOD levels established between Lachine and Quebec, etc.

## SOUTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Lot No. 256, Joseph Trudeau.	162.0	.....	.....	.....	56.87	55.27	Highest water of 1887 rose up to floor of veranda of Jos. Trudeau's house. In 1886 river was about 1.6 ft. higher than in 1887.
Lot No. 255, Grand Trunk Ry. Co.	161.8	.....	.....	.....	56.50	.....	Elevation of A. Irving's veranda floor, which was flush with water surface spring flood of 1886: 56.50; water rose, however, to 56.88 ft. while the roadway was blocked up by ice. If opening left for post road in railway embankment was closed up, and the road raised and graded so as to permit of driving over the track, the properties on the north-east side of the Victoria Bridge, would in a measure be protected from damage by high floods. (See notes and observations by M. Grant, Esq., Mayor of St. Lambert, in letter, dated May 6, 1887, Appendix No. 20.)
Lot No. 162, Noël and Pierre Marcille (lower end of lot).	160.9	.....	.....	.....	55.73	.....	Flood of 1886 rose to a point a little above underside of sill of cellar window in stone outhouse, as pointed out by Noël Marcille, who says that in 1887 water came within 18 inches of height it reached in the spring of 1886.
Lot No. 161, Joseph Tiffin (lower end of lot).	160.3	.....	.....	.....	54.81	52.71	Highest flood level of 1886 observed by Mrs. John Thompson, and marked on window sash opposite second pane of glass above sill. Ice jams badly here, between St. Helen's Island and east or south shore. Mrs. Thompson's property much damaged. In 1887 mark left by spring flood water on bars of veranda railing in front of J. Thompson's stone house.
Pump-house, Longueuil water works (upper end).	158.7	.....	.....	50.43	50.89	51.93	Flood marks made in pump-house by Mr. Octave Poirier, assistant engineer of the Longueuil water-works. (See remarks, etc., by L. E. Morin, Esq., Mayor of Longueuil, in letter addressed to Deputy Minister of Public Works, under date of April 28, 1887, Appendix No. 20.) With very high spring floods, the front road between Longueuil and St. Lambert is sometimes so much obstructed and cut up by ice and water, as to be impassable for weeks. At the lower end of the town of Longueuil, ice has also often to be chopped, to make a passage for vehicles going to or coming from Boucherville.
Longueuil Chas. Jalbert's shop on St. Charles st., between Rue St. Jean and Rue de l'Église.	158.4	.....	.....	.....	.....	51.58	Level reached by spring flood of 1887 pointed out by Mr. Charles Jalbert on the sash of his show window. Highest flood waters of 1886 said to have been about 2 ft. lower than those of 1887.
Terrapin hotel, west of Rue St. Charles	158.1	.....	.....	49.80	49.80	51.17	Height reached by spring floods in 1885 and 1886, at entrance steps to Terrapin hotel pointed out by T. Bourdon, Esq. In 1887 water rose up to first joint in brick work above floor of veranda in front of hotel.

TABLE XXVII.—*Continued.*  
 Flood levels established between Lachine and Quebec, etc.  
 SOUTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
North-west corner of St. Charles and Alexander streets.	158.0					51.31	Mark made at highest flood level of 1887, by J.-Bte. Bouthillier, on the brick at south-east corner of his house.
North-west corner of St. Charles and Charlotte streets.	157.8					50.64	Mark made at the water surface of 1887 by Mr. E. Benoit in the cellar door of his store.
North-west corner of St. Charles and St. Antoine streets.	157.7				49.09	50.03	Flood marks made in 1886 and 1887 on gate-post by Mr. Pierre Patenaude.
At junction of St. Antoine street and Post Road.	157.7					50.00	In 1887 flood waters rose to underside of batten at base of clapboarding at north-east end of ex-Mayor Hurteau's residence.
Toll gate at lower end of town of Longueuil.	157.3			48.98	46.40	48.98	Spring flood levels of 1885, 1886 and 1887 pointed out by Pierre Briard, toll-keeper, in the living room of the toll house. Water remained very high for 3 days in 1887.
Lot No. 27, Ant. Favreau.	156.2				46.27	47.60	Flood levels of 1886 and 1887 pointed out by Ant. Favreau on steps at rear entrance.
Lot No. 17, Joseph Dagnault.	155.9			47.35	45.39	45.39	Flood marks made in 1885, 1886 and 1887 by Joseph Dagnault on post close to north-east corner of his brick house.
Lot No. 19, George Charron.	155.2			46.38			Level of ground taken in front of dwelling house at height reached by flood waters in the spring of 1885, as pointed out by Mr. G. Charron.
Lot No. 5, Louis Dubuque.	154.8			46.11	44.44	44.97	In 1885 flood waters were flush with top of second lowest entrance-step of Mr. Dubuque's brick house, remaining near that level for about four days. In 1886 the river rose to batten around base of out-house, but remained only about four hours at this elevation. In 1887 it came to a point on the ground, in front of the dwelling pointed out by Mr. Dubuque.
Parish of Boucher-Ville.							
Co. of Chambly.							
Lot No. 4, Antoine Vinet.	154.2			45.36			Joint in brickwork of dwelling, up which water rose in spring of 1885, pointed out by Mr. A. Vinet.
Lot No. 43, Joseph Beaudou.	153.8			44.87		44.91	Top of one of the entrance steps of Mr. Beaudou's house, 3 inches under water in spring of 1885. In 1887, highest flood water flush with top of next lower step.
Lot No. 38, Toussaint Sixette.	153.5			45.21	45.08		Flood level of 1886 at top of sill around Mr. F. Sixette's house, at base of clapboarding. Flood level of 1887 1 to 2 inches lower.
Racicot's hotel.	152.6			45.30			Flood level of spring of 1886, marked by Armand Boucherville on the sign-post of Racicot's hotel, corner of St. Jean and Ste. Famille streets.
School-house of the Freres Viatoeurs.	152.4					43.86	Capping timber of protection work along river bank, in rear of the school-house of the Freres Viatoeurs, covered by six inches of water in the spring of 1887. This depth was measured by Brother Nadaud, and pointed out to me by him, in company with Dr. Demers, who was Mayor of Boucherville in 1887.

**TABLE XXVII.—Continued.**  
**Flood levels established between Lachine and Quebec, etc.**  
**SOUTH SHORE, RIVER ST. LAWRENCE.**

Locality.	Total distance in miles by river, above Quebec.	Maximum Elevations in feet above mean sea level of spring floods according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Corner of Ste. Famille and St. Charles sts.	152.4				44.86	44.03	In 1886, height of water observed by Madame Veuve Chas. Guimont, on entrance steps of her house. In spring of 1887 water came to top of sidewalk. Water remained but two or three hours at each of these extreme high elevations. The valuable properties on the Boucherville islands suffer more than any others in this vicinity from the effects of high spring floods, barns being carried away with all their contents, trees torn down, etc., by the ice.
Corner of Ste. Catherine and Ste. Famille sts.	152.3			44.92	44.92		Mrs. Chas. Senecal observed that in 1885 and 1886 the river rose to the top of the plank sidewalk at a point near the corner of Ste. Catherine and Ste. Famille sts.
Village of Varennes—west end. (Co. of Verchères).	147.8				44.92	43.98	Highest flood level of 1886, pointed out by Mr. L. P. Decelles. Water rose suddenly one day, from 11 a.m. to 2 p.m., covering the floor of the former house of J. Bte. Bienvenue, and remained high for several days. Highest level of 1887, as pointed out by J. Bte. Bienvenue; river remained very high only a few hours.
Village of Varennes, (near wharf).	147.5					43.65	Flood level of 1887, marked by L. H. Massue, Esq., ex-M.P., on poplar tree in his garden.
Village of Varennes. (½ mile below wharf).	147.4				43.36	43.27	Marks made by A. H. Bernard, Esq., on the fence of his garden.
Village of Varennes (lower end).	147.2			43.45	43.79		Height of spring flood level, pointed out by Madame DeMartigny. The water rose in 1862 to top of upper entrance steps, viz.: to an elevation of 42.73 feet, being the highest since 1859; in 1885, close to underside of parlour floor; in 1886, three inches over this floor. In 1886, the highest water obtained, 20th April, from 12 o'clock till 2 p.m., and in 1885, 28th April at 5 a.m., remaining very high only an hour or two.
do	147.2				43.65		Water observed in spring of 1886 by Xavier Petit, who stated that it rose up to within two inches of the top of one of his entrance steps.
do	147.2				43.79		Mr. Joseph Poirier observed that in the spring of 1886 the river rose to a point close to the underside of a window-sill on his house.
do	147.1					42.28	Highest level reached by flood in 1887 on Mr. Bienvenue's house, pointed out by Mr. X. Petit.
do	147.1				43.55	42.55	In the spring of 1886, water rose one inch over the oven of Mr. Joseph Cardin's stove, and in 1887 it only reached the fire door.
do	147.1				43.02	42.62	Mr. Francis Robert observed that the spring flood of 1886 rose to top of floor, north side of a small bridge on roadway, and that of 1887 only to the underside of this floor.

**TABLE XXVII.—Continued.**  
**Flood levels established between Lachine and Quebec, etc.**  
**SOUTH SHORE, RIVER ST. LAWRENCE.**

Locality.	Total distance in miles by river, above Quebec.	Maximum Elevations in feet above mean sea level of spring floods according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Parish of Verchères (Co. of Verchères). Lot No. 221, Elzéar Desmarais.	141 2 .....			44 41	41 42		Water rose in spring of 1887 to within 2 of the top of a large elm stump, pointed out by E. Desmarais. Highest flood water of spring of 1886, observed by Mr. E. Desmarais to stand at figure 7 of board gauge put up by him on a large ash tree, at request of Montreal Harbour Commissioners. River remained at this very high level, 44 41, only for about 4-hour.
At wharf, Verchères	138 9 .....			42 37 42 51	42 35 42 44	40 55	Flood marks made by Clement Dupré in his windmill, viz., on a door frame. Flood marks in 1885-86-87 made with a knife by Mr. Timothée Desmarais on his carpenter shop. In 1862 river rose to within one foot of the highest spring level of 1885, viz., say to 41 51 feet. Old residents state that the floods of 1885-86 were the highest experienced here during the previous eighty years.
Lot No. 33, Téléphore Chagnon.	137 5 .....			42 49	42 37		Flood marks made on a telegraph pole in a gully by Q. Chagnon.
Lot No. 30, J.-Bte. Moreau.	136 2 .....				42 39	41 18	Mark made at highest flood level of 1886 by J. Bte. Moreau, on a partition in his house, near the stove. Flood level of 1887 indicated on ground in front of his house.
Lot No. 18, Anne Bouvier.	136 2 .....			42 34	42 41		In 1885 flood came up to top of veranda floor of Mr. A. Bouvier's house, and in 1886 the water rose to top of sill of the entrance door.
Lot No. 12A, Phéoppe Chicome.	133 8 .....				42 07	40 40	High flood levels of 1885-87 marked by Mr. P. Chicome on his barn door. In 1886 water rose suddenly and remained very high during from one-quarter to one-half day; in 1887 it rose and receded gradually.
Parish of Contrecoeur (Co. of Verchères). Lot No. 260, Joseph Dansereau.	134 1 .....			41 39	42 49		Flood of 1885 rose to top of second entrance step, and that of 1886 up to landing or top of steps, the whole as pointed out by Mr. J. Dansereau.
Lot No. 248, Avila Gervais.	134 0 .....			42 14	40 49		Flood level of 1886 pointed out approximately on ground by Mr. A. Gervais; in 1887 highest spring waters reached to the top of one of the entrance steps of his house.
Lot No. 289, Augustin Laroche.	133 3 .....				42 40		Flood waters of 1886 covered door steps of Mr. A. Laroche's house.
Lot No. 286, J. Bte. Gervais.	132 3 .....				44 29		Highest flood level of 1886 at upper side of a step of Elzéar Lambert Boisjoli's house, N.W. angle, intersection of Port Road along south shore of St. Lawrence, with cross road to St. Denis.
Lot No. 235, Olivier Hubert.	132 0 .....			41 57			Highest flood level of spring of 1885 marked by Mr. Hubert with an axe on a maple tree close to his house.
Contrecoeur Village, 200 feet above wharf	121 0 .....			41 65	43 04	40 50	Flood marks made by Mr. Clement Chabot in and around his barn, pointed out by him at request of Mayor Duhamel. (See notes and observations by the Mayor, Vol. civ. No. 20.) In 1885 water remained very high three days, in 1886 only three hours, and in 1887 one day.

TABLE XXVII.—*Continued.*

FLOOD levels established between Lachine and Quebec, etc.

## SOUTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Contrecoeur Village: on road leading to wharf.	131.0	...	...	...	43.21	...	Spike driven into horse post by Montreal Harbour Commissioners' engineers, to indicate highest level reached by flood water in the spring of 1886.
Sorel (Co. of Richelieu.)	116.0	36.59	34.90	35.67	36.00	35.84	Flood levels of 1865 and 1887, according to observations made by P. De Bellefeuille, Esq., harbour master of Sorel; in 1887 Mr. De Bellefeuille was asked by Mayor A. A. Taillon to make a flood mark, in compliance with request addressed him by the Department of Public Works. Flood level of 1885 as pointed out by the Messrs. McCarthy, in front of their office at St. Joseph de Sorel. Flood level of 1886 as observed for Montreal Harbour Commissioners, 20th April, at 10 p.m. In 1887 water remained at top height only for an hour or so.
Yamaska Lock (Co. of Yamaska.)	108.2	...	...	...	...	33.54	Nail driven at flood level of 1887, by C. E. Michaud, Esq., C.E., into small tree on west shore of Yamaska River, opposite the lock. Dr. R. Mignault, Mayor of Yamaska, states he made no mark as requested by the department at the end of April, 1887, because he was absent from home at the time.
St. François du Lac (Co. of Yamaska.)	103.7	36.33	...	...	...	35.66	Highest level reached by the flood waters in the spring of 1887, made by Mayor H. Crevier, on his barn, west side of River St. Francis, 2½ miles below Abemakis Springs hotel, viz., in compliance with departmental request. Flood level of 1888 also pointed out by Mr. Crevier; elevation = 29.59 ft. Mayor Crevier stated that according to reports received from fishermen, the ice on Lake St. Peter was in 1887-88 only from 12 to 16 in. thick against 3.0 ft. generally; the absence of a flood in the spring of 1888 is partly ascribed to this circumstance. The main reasons of the ice having remained so thin appear to be as follows: 1st. The lake froze early and at a low stage of the water. 2nd. A short time after the ice took it was covered with a sufficient depth of snow to prevent the usual rapid thickening of the crust by frost. 3rd. There were no great thaws during the winter of 1887-88, and the snow was too deep to permit of the surface water passing through and becoming incorporated with the solid lake crust. Spring flood of 1865 rose 10 in. over parlour floor of Mr. François Varville's house.
La Baie du Fèvevre Village. (Co. of Yamaska.)	94.2	39.80	...	...	...	33.86	In 1865 the water was driven by a westerly storm to near the top of a box culvert on the post road opposite Jos. Duplessis' blacksmith shop, and in 1887 the lake reached to the foot of a gate post, which was pointed out by Mr. Duplessis.

TABLE XXVII.—*Continued.*  
 FLOOD levels established between Lachine and Quebec, etc.  
 SOUTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Nicolet..... (Ball's Mill, near mouth of River Nicolet.) (Co. of Nicolet.)	87.8			33.45	33.65	33.95	In the spring of 1887 the floor of Mayor G. Ball's office was 6 in. under water; in 1886 river rose 0.3 ft. less than in 1887, and in 1885 the water only came up to top of floor; the whole according to observations made by Mr. P. D. Poirier. Mr. Anselme Proulx, who resides a short distance to the eastward of Mr. Ball's mill, states that the highest water known here is that of 12th April, 1865, when the roadway was flooded to a depth of at least 12 ft. After the roadway was covered by 8 ft. of water, which put out the fire in Mr. Proulx's stove, a violent hurricane sprung up from the westward, which rolled up the waters to an additional height of 4 ft., raising, at the same time, swells sufficiently powerful to lift up the roof of his old stone house. Total loss suffered by Mr. Proulx estimated at \$1,500.
Parish of Nicolet, (Port St. Francis.) (Co. of Nicolet.)	85.4					34.12	In April, 1887, the river rose to the top of one of the steps of the flight leading up to the first floor of the house occupied by Mr. Ernest Duval, agent of the Richelieu and Ontario Navigation Company.
Parish of Ste. Angèle. (Village of Doucet's Landing.) (Co. of Nicolet.)	7.88	35.20				33.44 33.53	Flood mark No. 1 (33.44), made in the spring of 1887, 1.14 ft. below top of fence post at north-west corner of <i>Napoléon La mothe's</i> garden, by <i>Joseph Désilets, Esq.</i> , Secretary-treasurer Ste. Angèle, viz.: at the request of Mayor Léon Denoncourt, and with a view of supplying the information called for by the Public Works Department. Mark No. 2 (33.53), nail on G. T. Ry. wharf, near outer switch, which was covered by 2 inches of water at time of spring flood in 1887. Flood level of 1865 pointed out approximately by Mr. Antoine Bourgeois, 80 years of age, who stated that the water stood 1½ ft. deep in the road opposite his house.
Parish of Bécancour, (Mouth of River Bécancour.) (Co. of Nicolet.)	73.3	35.71				32.56	The spring flood waters of 1887 rose up to hook or staple on Mayor Louis Masse's barn; this level observed at special request of Public Works Department. In 1865 water came up to centre of lower panes of glass in <i>Zéphirin Champoux's</i> front windows. Mr. Champoux states that in 1873 the river was only 15 inches lower than in 1865.
Gentilly Village, opposite new parish church. (Co. of Nicolet.)	65.4	37.01				32.18	Spring flood level of 1887 observed by Mr. Louis Baril, near his house, at request of Mayor Marcell Tourville, with a view of furnishing information called for by the Public Works Department. Flood mark of 1865 on <i>Pascal Poissant's</i> house, 3.25 ft. above window sill, pointed out by Mr. Baril. Flood level of 1865 pointed out by Mr. Poissant.

TABLE XXVII.—*Continued.*

Flood levels established between Lachine and Quebec, etc.

## SOUTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
St. Pierre les Becquets, opposite parish church. (Co. of Nicolet.)	58.4	.....	.....	.....	.....	32.70	Frs. Magny, boatman, was commissioned in the spring of 1887, by Dr. D. U. Archambault, Mayor of St. Pierre, to make a mark at the highest flood level on the steps leading from the post road to the beach, viz.: in response to the call made by the Public Works Department. This order was carried out, but the flight of steps was displaced before the mark could be connected with a bench mark, hence the river level here is only approximate.
St. Jean Deschaillons (Co. of Lotbinière.)	52.9	.....	.....	.....	.....	.....	Joseph Laliberté, Esq., Mayor of St. Jean Deschaillons, called on 26th October, 1887. Mr. Laliberté received letter from Public Works Department asking him to mark highest spring flood level in 1887, too late to be able to comply with this request; it having reached him only after the débacle was all over. He pointed out, however, the highest level to which the spring flood rose in 1873; elevation of this water level = 33.60 ft.
Leclercville Village, Parish of Ste. Emelie de Lotbinière. (Co. of Lotbinière.)	46.5	.....	.....	30.24	.....	24.92	Highest flood levels of 1873 and 1885 marked on wall in Hon. H. G. Joly de Lotbinière's office, by the agent in charge of his saw-mills, Mr. F. Perrot; elevation of water in 1873 = 33.30 ft. In the spring of 1885 the ice was prevented from coming down Grande Rivière du Chêne, by the St. Lawrence water, which backed up into the former stream and piled up the ice to such a great height that the bridge on the post road, then quite new, was lifted up and carried away; elevation of flood waters at bridge site, 34.25 ft. Opinions of old residents of Leclercville and Lotbinière appear to be divided as to whether an ice blockade in the vicinity of Pointe Platon, or one at the narrow pass above the mouth of the Rivière Chaudière causes the greatest rise in the river level and damage to property. The highest flood level known in this locality, as well as at St. Jean Deschaillons, Grondines and Lotbinière was that which obtained in 1873.
Lotbinière .. (Old church flats.) (Co. of Lotbinière.)	43.4	.....	.....	.....	.....	.....	A mark was made by Laurent Beaudin, light keeper, at the request of Mayor Edouard Noël, on the Lotbinière lighthouse pier, to indicate the highest spring flood level of 1887, as asked by the Public Works Department in a circular addressed to Mr. Noël, in April, 1887. This mark appears to have been made too high, possibly at the surface of the ice instead of the water; its elevation above datum is 26.78 ft. In the spring of 1872 the water rose six inches over first step of flight leading up to Mr. Pierre Bernier's veranda, viz.: to an elevation of 33.94 ft. Notwithstanding

TABLE XXVII.—*Continued.*  
 FLOOD levels established between Lachine and Quebec, etc.  
 SOUTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum Elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
Lotbinière— <i>Con.</i>							that the water was very high in 1873, no damage was done; but a couple of years previous, when the river did not rise near so high, the ice damaged Mr. Bernier's blacksmith's shop, and shoved his house across from the north to the south side of the roadway. In 1873 the water covered the road for four to five days, and five buildings were flooded in this locality, some being badly damaged; other demolished. When the river is blocked a short distance above the Platon, the water is generally retained at a very high level at Lotbinière and vicinity during several days, because the large cakes and fields of ice which are shoved aground on to the foreshores at Portneuf, have to pivot through an angle of nearly 90° before they can make their way past Pointe Platon. When an ice bridge is formed at the "Sault," the channel of the Richelieu Rapid also generally freezes over opposite Lotbinière shortly after, so as to afford a safe crossing for vehicles. In years when the river remains open, an ice-boat ferry service is established between Lotbinière and Deschambault and Lachetvrotière on the south shore. This service is here performed with much greater facility than at Quebec city, for the strong current keeps the drifting lumps of ice well apart, so as to afford a comparatively free passage across the channel.
Pointe Platon (Co. of Lotbinière).	35 6 . . . . .	26 27 . . . . .			23 39		Flood marks made by Joseph Auger on Hon. H. G. Joly's boat house. Mr. Auger says that during the 20 years he lived at Platon, he never saw the water rise higher than in the spring of 1884; there was at that time no marked change in the river level at either ebb or flood during some eight days. The flood level of 1887 was marked by Mr. Auger at the special request of the Public Works Department.
Ste. Croix wharf (Co. of Lotbinière).	29 4 . . . . .	26 53 . . . . .	26 39 . . . . .				In the spring of 1884 the floor of Captain F. Boisvert's verandah was covered by 1½ inches of water, and in 1865 Captain Boisvert states, the river stood about 3½ inches over this floor. (See Mayor F. Boisvert's reply to departmental circular of 26th April, 1887, Appendix No. 20).
St. Antoine, foot of Cote's hill, 2 miles below parish church	19 6 . . . . .	26 34 . . . . .					Flood level of 1884 marked on Isaac Daigle's boat house at the foot of Cote's hill. Mayor N. Dion, in compliance with request of Public Works Department, made a flood mark on the same boat house; but Mr. Dion was absent when St. Antoine was visited 19th October, 1887, and no one present could point out the mark. (See Mr. Dion's reply to departmental circular, Appendix No. 20).

TABLE XXVII.—*Concluded.*

FLOOD levels established between Lachine and Quebec, etc.

## SOUTH SHORE, RIVER ST. LAWRENCE.

Locality.	Total distance in miles by river above Quebec.	Maximum elevations in feet above mean sea level of spring floods, according to local information.					Remarks.
		1865.	1884.	1885.	1886.	1887.	
St. Nicholas, Baker's wharf (County of Lévis).	11.3						In the vicinity of St. Nicholas the river banks are high and steep, hence no inconvenience is felt from spring floods, nor have I succeeded in obtaining any positive information relative to the flood levels of this part of the St. Lawrence, notwithstanding that tremendous ice shoves and jams occasionally take place, as may be judged from the following: Capt. Angus Baker, whose residence stands on a high plateau directly opposite his wharf, related to me that in the spring of 1884, at the time of the débâcle, it happened one day that the ice was piled up to such an extraordinary height in front of the wharf, as to completely hide from his view, when standing close to the fence in front of his house, the hills which rise directly opposite the latter on the north shore of the St. Lawrence. Special measurements were made with the object of determining the minimum height above the river bed of an obstruction from 200 to 600 ft. outside of the wharf, that would hide the hills on the north shore when viewed from the spot pointed out by Capt. Baker. The result of the computations made in this connection is: that the ice must have been piled up in the spring of 1884, from 110 to 125 ft. or more in height above the bed of the river.

In addition to the tidal diagrams and illustrations already mentioned, I further submit herewith :

1° A profile of the River St. Lawrence between Quebec and Lachine, in one length (Ill. No. XXIV.) ; horizontal scale  $\frac{1}{48000}$  or 4,000 ft per inch ; vertical scale  $\frac{1}{192}$  or 16 ft. per inch. From Quebec to Montreal the axis of the ship channel has approximately been followed, thence to Lachine, the waters edge, along both the north and south shores.\*

2° Two sets of typical local tide curves which obtain at the places where continuous series of tidal observations were made, plotted in chronological order and at their proper elevations above the mean level of the sea—together with two series of characteristic hourly instantaneous ebb and flood curves, extending from Quebec up to Lake St. Peter. In constructing the local curves, the times were laid down as abscissas to a scale of 1 inch per hour, and the heights of the water as ordinates to a scale of  $\frac{1}{2}$  inch per foot. The horizontal scale adopted for the hourly instantaneous curves is  $\frac{5}{8}$  miles per inch and the vertical  $\frac{1}{2}$  inch to the foot. (See Illustration No. XXV.)

#### PROFILE OF THE ST. LAWRENCE BETWEEN QUEBEC AND LACHINE.

##### *Illustration XXIV.*

On this profile several of the characteristic or typical flood and high and low water levels above determined and some instantaneous curves are laid down. The whole of the permanent and many of the temporary bench marks established on both sides of the river, are also indicated, together with the parishes, principal landing places, corrected establishments of the tide stations, etc., etc.

In constructing this longitudinal section of the river, the distances and depths were taken from the admiralty charts, cadastral and other maps obtained at the Québec Crown Lands Department, plans of the river furnished by the Montreal Harbour Commissioners and other documents on record in the Public Works Department.

In reference to the depths, I have to state that there exists in many cases much uncertainty respecting the particular stage of the river, or kind of tide, to which the soundings given on the plans correspond. Under the circumstances, I have endeavoured, both as regards depths and distances, to make the best use possible of the official documents and other information available, which, I may intimate, is neither as complete or reliable as would be desirable.

The various high and low water levels and loci and instantaneous curves indicated on the profile, may be enumerated and described as follows : commencing at the lowest near the eastern end, viz. :—

(a) Approximate lowest possible water level during season of navigation, at lowest known stage of river proper 20.85 ft. above datum at Verchères, with persistent high westerly winds and corresponding to springs of maximum importance (118) up to Pointe aux Trembles (*en bas*), or St. Croix, and to neaps of minimum importance (30), thence westward.

(b) Low water datum level proposed for the reduction of soundings, so as to indicate the minimum depths that may be safely counted upon for navigation purposes in the ship channel. This line represents, as already explained, the locus of the lowest possible troughs of tide waves, whether at springs or at neaps, with a fluvial discharge corresponding to the standard low mean river level of 21.50 ft. above datum at Verchères, and 16.0 ft. over mitre sill, foot of old lock No. 1, Lachine Canal : the weather, inclusive of atmospheric pressure, being assumed to be in a normal condition.

\* Profile of ship channel in one length lithographed  $\frac{64}{100}$  of original size, to accompany Official Report of Hon. the Minister of Public Works for fiscal year 1890-91. Horizontal scale  $\frac{1}{75000}$  or 6,250 ft. per inch ; vertical scale  $\frac{1}{300}$  or 25 ft. per inch.

(c) The level which the St. Lawrence would assume, approximately, if the estuary was abstracted from the influence of the tides, with 16 ft. depth over the sill of old lock No. 1, corresponding to mean surface elevation 21.50 ft. at Verchères. In such case the total fall would be from Montreal, foot of Lachine Canal, to the Graving Dock at St. Joseph de Lévis, Quebec harbour, 27.54 ft. — 1.15 ft. = 26.39 ft. in a distance of 163½ miles.

(d) Instantaneous curve, ordinary ebb, low water season (October, 1887), corresponding to half-tide level at St. Jean Deschaillons.

(e) Instantaneous curve, ordinary flood, low water season, corresponding to half-tide level at St. Jean Deschaillons.

These two instantaneous low water curves are for a tide having an astronomical coefficient of about 71, with the river level 22.0 ft. above datum at Verchères, and 16.5 ft. over the sill of old lock No. 1, Lachine Canal. They represent the mean of the longitudinal profiles presented by four waves having coefficients of 39, 117, 41 and 86.

(f) Instantaneous curve, ordinary ebb, high water season (May, 1888), corresponding to half-tide level at St. Jean Deschaillons.

(g) Instantaneous curve, ordinary flood, high water season; corresponding to half-tide level at St. Jean Deschaillons.

These two instantaneous high water curves are for a tide having an astronomical coefficient of 70, with the river level 30 ft. above datum at Verchères, and 23.0 ft. over sill of old lock No. 1, Lachine Canal. They indicate the mean of the longitudinal profiles of four fluvial waves having coefficients of 44, 82, 46 and 107.

(h) Lowest water possible at high tide during season of navigation with river at lowest normal stage.

(i) Highest water possible at high tide during season of navigation, with river at lowest normal stage.

The first of the two water lines last described is the locus of the wave summit of a neap tide of minimum importance, with a theoretical amplitude corresponding to coefficient 30; and the second, the locus of the summit of a spring tide of maximum astronomical importance corresponding to coefficient 118; the river being in each case at the low normal stage when the water surface stands at elevation 21.50 ft. at Verchères, and 16 ft. over the sill of old lock No. 1, Lachine Canal.

(j) Highest water possible during season of navigation, with weather, including atmospheric pressure, in a normal state. This, as already explained, is the locus of the high tide levels of a spring tide having a theoretical amplitude of 108 (the highest possible in May), with the river at the highest known level, viz., 36.32 ft. over datum at Verchères.

(k) Highest water observed at Quebec and vicinity during the season of navigation, viz., 5th November, 1884, resulting from spring tides of a theoretical importance of 106, driven up by a north-easterly hurricane; the river being 17.6" over sill old lock No. 1, Lachine Canal.

(l) Approximate locus of highest known levels reached by floods resulting from obstruction of waterway by ice or from wind pressure, or from both combined, from St. Augustin and St. Nicholas to Montreal and Lachine Rapids.

#### LOCAL AND INSTANTANEOUS TIDE CURVES.

#### *Illustration No. XXV.*

These curves correspond:

(a) To the spring tide of greatest importance, observed at the time of the year (autumn) when the oceanic waves are least disturbed by the fresh water discharge of the river, viz.: to the spring tide of 18th October, 1887, when the depth on the lower mitre sill of old lock No. 1, Lachine Canal, was 16.67 ft., and the astronomical tidal coefficient 117, or only 1 below its greatest possible value (118).

(b) To the least neap tide observed during the season (spring) when the regular propagation of the pendular oscillations generated in the open Atlantic, is interfered

with to the greatest possible extent by the large volume of drainage water carried by the River St. Lawrence, viz.: to the neap tide of 20th May, 1888, having a theoretical coefficient of 46, and with a depth of from 24.5 ft. to 24.6 ft., on the lower mitre sill of the lock just mentioned.

In all the local tide curves of places on the upper portion of the St. Lawrence which have been constructed, only one maximum obtains between the two consecutive low tide levels and one minimum between two consecutive high tide levels, nor do these curves appear to possess any features that might be considered singular or original in other respects, and that require to be specially noticed. The local curves serve to show, in a striking manner, the decreased duration of the floods and the correspondingly increased duration of the ebbs as we proceed up stream, which is the case on all estuaries; also, the extent to which the low water level may sink to the eastward of, say, Ste. Croix, and rise simultaneously to the westward of this place during series of gaining tides, or *vice versa*, when the tides are losing in importance, the diminished amplitudes of the high water season in comparison to those of the low water season.

Possibly some swellings and depressions in the local curves may be caused, here as along other sea coasts, by undulations having shorter periods than half a lunar day; but this can in any case be satisfactorily ascertained only at points on the lower St. Lawrence, where the regular propagation of the tidal oscillations is much less disturbed by the fresh water discharge and marked changes in the elevation and general conformation of the bed of the estuary than above Quebec city.

The hourly instantaneous curves indicate clearly the nature of the surface declivities of the St. Lawrence estuary, for typical phases of the fluvial intumescence which is generated by spring tides of very nearly absolute maximum astronomical importance when the river is at a very low stage, and also for corresponding phases of low astronomical neaps at the time the fresh water stream is most powerful.

On Admiralty Charts "No. 2830a—from Quebec to Pointe du Lac" (Ill.: XXVI.) and "No. 2830b—From Pointe du Lac to Lachine" (Ill. XXVII.), to both of which reference has already been made herein, the lines of geodetic levels run along the rivers Richelieu and St. Lawrence, inclusive of river crossings, check and loop lines, etc., are laid down and the positions of the bench marks indicated, all in red. Average scale of map No. 2830a, 10,325 ft. per inch, ditto of map No. 2830b, 10,423 ft. per inch nearly, shrinkage of paper taken into account in both instances. The most important results deduced from the complete monthly series of tidal observations and river gaugings which were made during the low water season of 1887, and the high water season of 1888 as well as the description and elevations of the more prominent bench marks, have been printed on the charts in tabular form, also in red. The axis of the ship channel and the elevations above the mean level of the sea of the low water datum level proposed for the reduction of soundings, so as to indicate the minimum depths that may be safely counted upon for navigation purposes in the said channel, are shown in blue.

Finally, a profile of the St. Lawrence ship channel between Quebec and Montreal, including, besides all the characteristic tide and river levels already enumerated, the approximate line to which the Admiralty soundings appear to have been reduced, and a profile of the navigable channel of the whole River Richelieu, from Rouse's Point, Lake Champlain, to Sorel, have been added on these charts to a horizontal scale of 30,000 ft. and a vertical scale of 40 ft. per inch, as also, reductions of the series of typical local and instantaneous hourly tide curves already described.\*

\* The charts, with additions above described, have been reproduced by lithography, each in two parts, having the same width as the Official Report and marked a and b; the plans of the rivers being enlarged uniformly to 1:50,000, which corresponds to a scale of 10,000 ft. per inch.

Illustration No. XXVIa comprises the plan of the River St. Lawrence, Quebec to Pointe du Lac, with corresponding profile of ship channel. On No. XXVIb are shown the local and instantaneous hourly tide curves, together with the chief results of the tidal observations and river gaugings of 1887-88, in tabular form.

No. XXVIIa is a plan of the St. Lawrence, Pointe du Lac to Montreal and Lachine, with corresponding profile of ship channel, etc. No. XXVIIb is a plan of the whole River Richelieu to the same scale as the St. Lawrence, viz.: 10,000 ft. per inch, with profile of navigable channel.

## RATES OF RISE AND FALL OF TIDES, QUÉBEC TO BATISCON.

According to the typical local tide curves constructed and the results of the series of continuous observations made in 1887-88 generally, the maximum rates of rise and fall of the tide water obtained at the gauging stations between Quebec and Batiscon, under ordinary conditions as regards wind and weather, at springs of maximum importance during the low water season of the year, viz. : as shown hereunder :—

TABLE XXVIII.

Gauging Stations.	Maximum rates of rise of flood.	Time after low water.		Maximum rates of fall of ebb.	Time after high water.	
	Feet per hour.	H. M.	H. M.	Feet per hour.	H. M.	H. M.
Levee Graving Dock.....	9'00	0'23	to 0'48	4'90	0'46	to 1'32
Chaudière.....	7'80	0'13	" 0'43	3'60	0'37	" 1'55
St. Nicholas.....	6'90	0'14	" 0'48	3'00	0'42	" 1'45
Ponte Platon.....	5'60	0'11	" 1'13	3'00	0'28	" 1'11
Grandines.....	3'60	1'11	" 2'11	2'10	0'33	" 1'07
St. Jean des Chaillons.....	2'80	1'03	" 2'24	1'60	0'20	" 0'57
Batiscon.....	2'00	1'04	" 1'41	0'80	0'08	" 0'42

In computing the typical mean rates of rise and fall which are entered in the following table (XXIX.), the portions of both the ebb and flood tide ranges corresponding to the stand within 0.05 ft. at high and low water, have been purposely eliminated throughout. This was done with a view of indicating, as closely as practicable, in connection with the above absolute maximum and minimum rates, the general nature of the hourly fluctuations, in the level of the estuary at the gauging stations during the high and low water seasons.

TABLE XXIX.

Gauging Stations.	Mean rates of rise of floods observed during the low water season of 1887, corresponding to :			Mean rates of fall of ebbs observed during the low water season of 1887, corresponding to :			Mean rates of rise of floods observed during the high water season of 1888, corresponding to :			Mean rates of fall of ebbs observed during the high water season of 1888, corresponding to :		
	Average ranges		Average ranges	Average ranges		Average ranges	Average ranges		Average ranges	Average ranges		Average ranges
	Maxi-mum	Mini-mum		Maxi-mum	Mini-mum		Maxi-mum	Mini-mum		Maxi-mum	Mini-mum	
	spring ranges	neap ranges		spring ranges	neap ranges		spring ranges	neap ranges		spring ranges	neap ranges	
	Feet per hr	Feet per hr	Feet per hr	Feet per hr	Feet per hr	Feet per hr	Feet per hr	Feet per hr	Feet per hr	Feet per hr	Feet per hr	Feet per hr
Levee Graving Dock.....	4'20	2'02	2'91	2'36	1'42	1'92	4'18	2'15	3'01	2'20	1'39	1'84
Chaudière.....	3'85	1'99	2'87	2'29	1'49	1'89	4'04	2'11	2'90	2'18	1'38	1'80
St. Nicholas.....	4'00	2'03	2'85	2'20	1'50	1'87	3'72	2'08	2'80	2'08	1'36	1'77
Ponte Platon.....	3'43	2'13	2'65	1'79	1'31	1'56	3'66	2'04	2'79	1'60	0'90	1'27
Grandines.....	2'46	1'32	1'95	1'09	0'72	0'96	2'66	0'83	1'59	0'78	0'33	0'58
St. Jean Deschaillons.....	1'88	0'93	1'45	0'81	0'58	0'66	1'87	0'49	1'04	0'53	0'18	0'35
Batiscon.....	1'37	0'34	0'87	0'44	0'17	0'30	1'11	0'19	0'49	0'26	0'08	0'16

TABLE XXX.

Slope of St. Lawrence, corresponding to lowest normal tide and river levels between Quebec and Montreal.

No. of Reach.	Total distance above Graving Dock in miles.	Intermediate distances in statute miles.	Localities.	Surface declivity of stream in feet, corresponding to low water datum, proposed for minimum depth in ship channel.	Hydraulic inclination in feet per mile.
1 <sup>st</sup>	0	8½	Graving dock, St. Joseph de Lévis.	0.010	0.00120
2 <sup>nd</sup>	8½	1	Lower end of narrow gorge on St. Lawrence, known under the name of "Le Sault," near mouth of River Chaudière.	0.360	0.36000
3 <sup>rd</sup>	9½	4½	Basile's Hill (south shore). Upper end of narrow gorge known as "Le Sault."	0.755	0.17765
4 <sup>th</sup>	13½	2½	Baker's wharf, St. Nicholas (south shore).	0.875	0.35000
5 <sup>th</sup>	16	4	Point 1¼ mile below St. Augustin church (north shore).	0.840	0.21000
6 <sup>th</sup>	20	17½	Pointe Aubin (south shore) or Fréchette's Island (north shore).	0.749	0.04280
7 <sup>th</sup>	37½	4½	Pointe Platon, Hon. Mr. Joly de Lotbinière's wharf.	0.281	0.06244
8 <sup>th</sup>	42	2½	Foot of Richelieu Rapid, opposite Deschambault wharf, ½ mile below Richelieu Island.	3.760	1.50400
9 <sup>th</sup>	44½	4½	Head of Richelieu Rapid, opposite Lotbinière church.	0.450	0.10000
10 <sup>th</sup>	49	2½	Grondines wharf (north shore).	0.940	0.37600
11 <sup>th</sup>	51½	2½	Grondines Point (north shore) and Cap Charles (south shore).	1.474	0.58960
12 <sup>th</sup>	54	1½	St. Jean Deschaillons wharf, Cap à la Roche.	2.406	1.60400
13 <sup>th</sup>	55½	6	Head of Cap à la Roche rapid.	1.282	0.21367
14 <sup>th</sup>	61½	7½	Batiscan (north shore), Brunelle's wharf.	1.108	0.15283
15 <sup>th</sup>	68¾	8½	Champlain, Gagnon's wharf.	1.280	0.13515
16 <sup>th</sup>	77	3¾	Head of Provencher shoal.	1.160	0.30933
17 <sup>th</sup>	80¾	6½	Grand Trunk Railway wharf, Doncet's Landing, south shore, opposite Three Rivers.	0.110	0.01466
18 <sup>th</sup>	87	20¾	Port St. Francis, lower end of Lake St. Peter.	1.610	0.07759
19 <sup>th</sup>	107¾	9¾	Mouth of River Yamaska, head of Lake St. Peter.	1.070	0.10974
20 <sup>th</sup>	117½	18	Sorel, mouth of River Richelieu.	2.170	0.12065
21 <sup>st</sup>	135½	4¾	Upper end of chain of islands along south shore, 3 miles above Contrecoeur wharf.	0.400	0.08421
22 <sup>nd</sup>	140½	8½	Vercheres wharf.	1.570	0.18471
23 <sup>rd</sup>	148¾	5	Varennés wharf.	1.060	0.21200
24 <sup>th</sup>	153¾	5½	Boucherville wharf.	1.130	0.20645
25 <sup>th</sup>	159½	1¾	Longueuil Government wharf.	0.680	0.38837

TABLE XXX.—*Con.*

Slope of St. Lawrence, corresponding to lowest normal tide and river levels between Quebec and Montreal.

No. of Reach.	Total distance above Graving Dock in miles.	Intermediate distances in statute miles.	Localities.	Surface declivity of stream in feet, corresponding to low water datum, proposed for minimum depth in ship channel.	Hydraulic inclination in feet per mile.
35	161	.....	Foot of St. Mary's current, opposite Ile Ronde.	1' 000	2' 60667
	161½	.....	Head of St. Mary's current, opposite St. Helen's Island ferry landing.		
27	162½	1½	Foot of Lachine Canal.	0' 680	0' 49455
	162½	.....	Totals.....		
				29' 210	

Inward bound vessels for the port of Montreal, have to ascend portions of one or more, and possibly of the whole of the characteristic acclivities of the stream enumerated and described above in Table XXX., which obtain during the low water season between Quebec and Montreal.

According as the speed of the incoming ship exceeds or falls short of the rate of advance of the head of the flood, the incline which she has to ascend at any point is steeper or flatter than that indicated in the table. On the other hand, the benefit which a vessel going down the St. Lawrence derives at any point, as regards impulsion, from the slope of the stream is, during floods: smaller than that which would result from the corresponding declivity given in Table XXX.; diminishing as the speed of the ship increases, and during ebbs: larger than the tabular declivity; increasing with the speed of the ship.

#### TIDAL CURRENTS INDUCED BY FLUVIAL UNDULATIONS.

On the St. Lawrence, as in the tideway of every other large river flowing into the sea, the stream of ebb continues to make at any point P, for a short time, say  $\frac{1}{4}$  to 1 hour, or more, after the hour of low water. During this space of time a portion of the liquid needed to insure the unbroken propagation of the incoming fluvial intumescence caused by an oceanic tide wave, viz., over the part of the estuary lying below the point P, is derived from the drainage water carried by the river proper and the body of tide water accumulated in the estuary on the up stream side of the cross section corresponding to the said point.

At slack water of ebb, no more river or tide water from above is required, to satisfy the condition just mentioned of the continuous propagation of the fluvial undulation, which is thenceforth formed entirely by liquid drawn from the portion of the estuary on the down stream side of the cross section at P. After increasing gradually for some time, say from  $\frac{1}{4}$  to 1 hour, or more, from the instant of slack water, the longitudinal translation of liquid particles in the fluvial undulation proper up the estuary, which constitutes the stream of flood, continues to take place in a comparatively uniform and steady manner for, say, from 1 to 3 hours. After this, the flood stream gradually loses in strength, and makes after high water during the ebbing of the tide, for just such a length of time as will, under the circumstances, ensure the continuous propagation of the ascending wave on the up stream side of P, with the least possible expenditure of energy.

At the instant of slack water of flood, the horizontal translation of liquid particles from the down stream to the up stream side of P is needed no more to satisfy the condition just mentioned of the formation of the incoming undulation, and the tide water remaining in the estuary commences to return seaward, constituting the stream of ebb. This stream assumes a velocity in accordance with the slope that establishes itself at every instant either between the summit of the tide wave and the sea, when, as is invariably the case in tideways of moderate length, one-half an undulation, at most, can find place therein at one time, or else between the wave crest and the head of the incoming flood, when the estuary is of such vast proportions, as in the case of the St. Lawrence, that the whole force of one tidal oscillation is expended previous to a second wave making its way up the river.

For an hour or two, or more, from slack water of flood, the outward current gradually gains in strength till the flow becomes comparatively steady and uniform, and thus the water continues to flow seaward for from 3 to 5 hours or more, when the stream of ebb diminishes in a sensible manner until it becomes perfectly slack again, a short time after low water. As already explained, the length of time which this stream, yet steady at dead low water, continues to obtain thereafter while the tide rises, is such; that the quantity of liquid required for the unbroken propagation of the fluvial wave on the down stream side of the point P, up to the instant of slackwater of ebb, may be supplied in the easiest way possible under the circumstances.

It is noteworthy that the direction followed by the tidal stream at any point P, cannot always be inferred from that of the surface slope of the water. In the portion of the estuary between Quebec and Batiscan, the stream of ebb continues, as well known, say 1 to 3 hours, or more, after low water, and while at Quebec the stream of flood already makes about 1 hour after low water; at Batiscan this stream practically ceases to be felt, nevertheless, at springs, during the low water season, the surface declivity of the river assumes, at every point along this stretch, a westerly or up stream direction, immediately after the tide reaches its lowest point. In the spring of the year, however, when the volume of drainage water, carried by the river proper, is very great, the surface slope of the tideway is, at low water of neaps, generally, if not always, in an easterly or down stream direction at points to the westward of Pointe Platon.

In the summer of 1882, while engaged on the hydrographic survey between Quebec and Cap à la Roche, which was commenced under my direction in 1881, I had velocities of tidal currents measured at several points in the ship channel between Pointe aux Trembles (*en bas*) and Pointe Platon. The measurements were made with Massey's patent log, at intervals of 5 minutes; the current meter being immersed now for 5 and again for 10 minutes at a time. The rise and fall of the tide was also ascertained simultaneously, with the aid of a tide staff anchored out in the river, beyond low water mark, in about 8 feet depth; the elevations of the water registered at intervals of from 1 to 6 minutes.

On Saturday, 26th August, 1882, when an easterly to south-easterly breeze of from 4 to 16 miles an hour was blowing, measurements were made continuously at a point in the ship channel  $2\frac{1}{2}$  miles below Pointe aux Trembles wharf, from 9-30 a.m. to 6 p.m., an interval which covered fully an entire flood tide of 4 hours and 55 minutes duration, and having a range of 11-10 ft., together with the first quarter of the succeeding ebb past slack water, and the last three quarters or so of the preceding ebb. Again, on the following Monday, 28th August, 1882, when there was little or no wind, a series of current measurements was made, embracing a complete ebb of 7 hours and 51 minutes duration, and having an amplitude of 14-0 ft., together with the first half or so of the succeeding flood, viz., past slack water.

On illustration No. XXVIII. are shown, at the proper elevation above the approximate mean sea level datum, local tide curves in blue and corresponding current curves in red, which are based on the observations and measurements made 26th and 28th August, 1882, above referred to. In constructing the current curves the times were represented by abscissas, one inch being allowed per hour, the same as the local tide curves, while the scale of the ordinates was fixed by the consideration that the differ-

ence in elevation of the slack water levels of ebb and flood would have to indicate the total distance passed over by the stream, in each case, between two consecutive instants of slack water.

TABLE XXXI.

## FLOOD STREAM.

Time, Saturday, 26th August, 1882.	Elevation of Water.	+ $r$ Rate of rise of flood, — $r$ Rate of fall of ebb.	+ $v$ Velocity of stream of flood, — $v$ Velocity of stream of ebb.	$\frac{v}{r}$	Remarks.
	Feet above datum.	Feet per hour.	Miles per hour.		
12:10 p.m.	4:35	—1:26	—3:5572	.....	
12:30 do	3:90	—1:20	—3:7696	.....	End of steady ebb stream.
12:50 do	3:70	0:00	—3:5615	.....	Dead low water.
1:15 do	4:10	2:28	—2:6911	.....	
2:00 do	6:47	2:76	—0:1391	.....	
2:17 do	7:33	3:03	0:0000	0:0000	Slack water of ebb.
2:30 do	7:99	2:40	0:3399	0:1416	Pleasant south-easterly breeze.
2:40 do	8:29	2:28	0:5141	0:2255	
2:50 do	8:75	2:88	1:2668	0:4398	
3:00 do	9:25	2:73	1:7577	0:6438	1:952 ft. per hour maximum velocity of flood stream.
3:15 do	9:86	2:58	1:9520	0:7566	
3:20 do	10:06	2:67	1:8912	0:7083	
3:40 do	11:00	2:64	1:9273	0:7300	
4:00 do	11:96	3:27	1:8158	0:5553	
4:20 do	13:03	2:55	1:6750	0:6569	
4:30 do	13:37	1:68	1:5920	0:9476	Wind easterly, 8 miles per hour.
4:40 do	13:59	1:38	1:5892	1:1516	
4:50 do	13:83	2:13	1:5167	0:7121	
5:00 do	14:30	2:01	1:2833	0:6409	
5:10 do	14:50	0:90	1:2252	1:3613	
5:20 do	14:60	0:90	0:9828	1:0920	
5:30 do	14:79	0:60	0:7742	1:2903	
5:45 do	14:80	0:00	0:2880	.....	Top high water.
5:50 do	14:80	—0:30	0:1900	.....	
6:16 do	14:38	—1:23	0:0000	.....	Slack water of flood. South-east wind, 16:8 miles per hour.
6:30 do	14:09	—1:29	—0:1841	.....	

Now the corresponding local flood and current curves for August 26, 1882, plotted in accordance with the above data (*See illustration No. XXVIII.*) are both, not only nearly straight; but also nearly parallel during the interval of 1h. 30m. between 3 p.m.—or 2 hours and 10 minutes after low tide—and 4.30 p.m., or one hour and 15 minutes within the succeeding high water. Hence, at Pointe aux Trembles (*en bas*) during the interval of flood just mentioned, or any corresponding interval; the value of the

ratio  $\frac{v}{r}$  between the rate of rise  $r$  of the flood, and the velocity  $v$  of the current, re-

mains sensibly the same, and is nearly equal to the mean value of  $\frac{v}{r}$ , corresponding to

the interval between slack water of ebb and the succeeding slack water of flood.

It will be seen, nevertheless, from an inspection of the results entered in table XXXI., that although the general parallelism of the corresponding flood tide and current curves indicates that  $\frac{v}{r}$  is on the whole directly proportioned to  $r$ : on 26th August, 1882, both the rate of rise  $r$  of the tide and the velocity  $v$  of the flood stream

oscillated incessantly within narrow limits about their average or continuous values, and it looks as if  $v_f$  and  $r$  varied, sometimes at least, in opposite directions. No doubt, some of these passing irregularities are due to errors of observation made in estimating the elevation of the water, as indicated by a plain tide staff anchored out in the river, and therefore unprotected from swells and the splash of waves. Some irregularities were also probably caused by the easterly breeze which was blowing at the time, others again by passing vessels, indeed, the water in the basin between St. Nicholas and Pointe Platon appeared to be almost continually in an unsettled state of equilibrium.

Mean value of  $\frac{v_f}{r}$ , for the interval of 1h. 30m. from 3 p.m. to 4.30 p.m.=

$$\frac{1.8319 \text{ miles p. hour}}{2.75 \text{ ft.}} = 0.6661.$$

Mean value of  $\frac{v_f}{r}$  from slack water of flood, at 2h. 17m., viz : 1h. 27m. after low water, to slack water of ebb at 6h. 16m. p.m., viz : 31 minutes after high water, forming an interval of 3 hours and 59 minutes =

$$\frac{1.1825 \text{ miles p. hour}}{1.7699 \text{ feet per hour}} = 0.6682.$$

TABLE XXXII.

## EBB STREAM.

Time, Saturday, August 28, 1882.	Elevation of Water.	-r. Rate of fall of ebb. +r. Rate of rise of flood.	-r. Velocity of stream of ebb. +r. Velocity of stream of flood.	$\frac{v}{r}$ .	Remarks.
	Feet above datum.	Feet per hour.	Miles per hour.		
A.M.					
6.46	17.90				N.N.W. wind barely perceptible. Top high water.
7.15	17.57	-1.38	0.000	0.000	Slack water of flood.
7.45	16.39	-2.22	-0.7383	0.3326	
8.00	15.84	-2.40	-1.4339	0.5975	
8.30	14.64	-2.28	-2.7511	1.2066	Calm.
9.00	13.50	-2.37	-3.3685	1.4213	
10.00	11.45	-1.77	-4.1931	2.3690	
11.00	9.66	-1.50	-4.2321	2.8214	Sky overcast.
12.00	7.83	-1.83	-4.3541	2.3793	S.S. wind just perceptible.
P.M.					
1.00	6.14	-1.92	-4.6892	2.4423	
2.00	4.58	-1.38	-4.4352	3.2139	
2.15	4.25	-1.26	-4.8273	3.8312	4.827 miles per hour, maximum velocity of ebb stream.
2.39	3.90	-0.00	-4.3704	S	Dead low water.
3.00	4.61	+3.66	-3.1115	.....	
3.15	5.56	+4.62	-1.9554	.....	Calm.
3.45	7.84	+3.90	0.0000	.....	Slack water of ebb.
4.00	8.54	+2.55	+0.2063	.....	Northerly wind, 2 miles per hour.
4.15	9.14	+2.82	+1.1410	.....	
4.45	10.86	+3.42	+2.4184	.....	Wind gone down.

Mean value of  $\frac{v_e}{r}$  from 10 a.m. to 2.30 p.m.—an interval of 4h. 30m. during which the ebb stream remained nearly uniform :

$$= \frac{4.4030 \text{ miles per hour}}{1.6711 \text{ feet per hour}} = 2.6348.$$

Mean value of  $\frac{v_e}{r}$  from slack water of flood at 7.15 a.m., or 29 minutes after high water, to slack water of ebb at 3h. 45m., or 1h. 6m. after low water, forming an interval of 8h. 30m. =

$$\frac{3.4860 \text{ miles per hour}}{1.1447 \text{ feet per hour}} = 3.0453.$$

Information respecting the elevations of various points above mean sea level, etc. has already been furnished, upon application, to many engineers and other parties, among whom are the following gentlemen :—Rev. Professor A. K. Laflamme, Laval University ; Thos. Monro, Esq., E. H. Parent, Esq., St. Geo. Boswell, Esq., Thos. Berlinguet, Esq., and J. O. Mignault, Esq., Civil Engineers ; and Dr. L. Laberge, Medical Officer, Montreal, and it is desirable that all levels taken hereafter, for this or any other department of the public service, be referred to the mean sea level by connecting the same, whenever practicable, with one of the geodesic bench marks made under my direction.

As regards this department, a circular over your own signature addressed to the engineers under your control would evidently prove the best, if it is not the only way of attaining the object in view, viz. : the adoption of one and the same datum (the mean level of the sea) for all elevations determined, whether of the water or of the land.

In conclusion, I have again to bring under your notice the important services which have been rendered, both in the field and in the office, by Mr. Chas. Chaloner, as assistant engineer and draughtsman, and Mr. H. J. Friel as principal rodman, computing clerk, etc. I may add that in connection with the work, Mr. Alf. Dostaler has proved himself to be a competent, painstaking employee.

I have honour to be, sir,

Your obedient servant,

(Signed) R. STECKEL,

*Engineer in charge.*

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**PUBLIC WORKS, CANADA,  
GEODETIC LEVELLING.**

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**WATER LEVELS, RIVER ST. LAWRENCE,**

**BETWEEN**

**QUEBEC, MONTREAL AND LACHINE.**

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**LIST OF ILLUSTRATIONS ACCOMPANYING REPORT ADDRESSED TO  
CHIEF ENGINEER, BY R. STECKEL, ENGINEER IN CHARGE  
OF LEVELLING AND GAUGING OPERATIONS, ETC.,  
UNDER DATE OF 24<sup>TH</sup> NOVEMBER, 1891,  
INCLUDING REFERENCES TO  
COLOURS USED ON SAME.**

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**REPORT**  
ON  
**WATER LEVELS, RIVER ST. LAWRENCE,**  
**BETWEEN**  
**QUEBEC, MONTREAL AND LACHINE**

BY  
**R. STECKEL, CIVIL ENGINEER**

24TH NOVEMBER, 1891.

List of accompanying illustrations and references to colours used on the same.

- \*I.—View of tide gauge, as put up for transportation.
- \*II.—Tide gauge in position for work.
- \*III.—Diagrams showing vertical movements of summits and troughs of tide waves for: 1°. Cumberland Basin, Bay of Fundy; 2°. Baie Verte, Gulf of St. Lawrence; 3°. Rimouski; 4°. Quebec City; 5°. Pointe Platon; 6°. Grondines; 7°. Sorel, high and low water levels, plotted as ordinates in the order of the ranges of tides: these being laid down as abscissas. Scale 5 ft. per inch.
- \*IV.—Diagrams showing discrepancies between computed and observed times of high water, for the low water season of 1887, and the high water season of 1888, Lévis Graving Dock. Scale of abscissas, 40 hours per inch. Scale of ordinates, 20 minutes per inch.
- \*V.—Diagrams showing discrepancies between computed and observed times of high water, for the low water season of 1887 and the high water season of 1888, Batiscan. Scale of abscissas, 40 hours per inch. Scale of ordinates, 20 minutes per inch.
- \*VI., VII., VIII., \*IX., X.—Diagrams showing fluctuations of high, low and mean tide levels at the Lévis Graving Dock, River Chaudière, St. Nicholas, Pointe Platon, Grondines, St. Jean des Chaillons, Batiscan and Champlain gauging stations, during the low water season of 1887. Scale of abscissas, 20 hours per inch. Scale of ordinates, 2 ft. per inch.
- \*XI.—Diagram showing tide and river water fluctuations during the low water season of 1887 at Doucet's Landing (opposite Three Rivers), Port St. Francis, Sorel, Contrecoeur, Verchères and Longueuil. Scale of abscissas, 20 hours per inch. Scale of ordinates, 2 ft. per inch.
- XII., XIII., \*XIV.—Diagrams showing fluctuations of high, low and mean tide levels at the Lévis Graving Dock, River Chaudière, St. Nicholas, Pointe Platon, Grondines, St. Jean des Chaillons, Batiscan and Champlain gauging stations, during the high water season of 1888. Scale of abscissas, 20 hours per inch. Scale of ordinates, 2 ft. per inch.
- \*XV.—Diagram showing tide and river water fluctuations during the high water season of 1888, at Doucet's Landing, Port St. Francis, Sorel, Contrecoeur, Verchères and Longueuil. Scale of abscissas, 20 hours per inch. Scale of ordinates, 2 ft. per inch.

- XVI. to XXII.—Diagrams showing geometrical loci of amended high and low tide levels for the low and high water seasons, at the Lévis Graving Dock, St. Nicholas, Pointe Platon, Grondines, St. Jean Deschaillons, Batiscan and Champlain gauging stations ; also, loci of amended river levels at Verchères, as taken off diagrams Nos. VI to XV when plotted as ordinates in the order of the corresponding astronomical coefficients of tidal importance laid down as abscissas. Scale of abscissas, 10 hundredths (centièmes) per inch. Scale of ordinates, 2 ft. per inch.
- \*\*XXIII.—Diagram showing simultaneous gaugings made under the supervision of the Montreal Flood Commission at Laprairie, St. Lambert, Montreal, Hochelaga, Longue Pointe, Boucherville, Varennes and Sorel, December, 1886, to April, 1887, at their proper elevations above the mean sea level datum.
- †XXIV.—Profile of the River St. Lawrence between Quebec and Lachine, in one length, on which are shown the loci of normal and extreme high and low tide levels at high and low stages of the river ; instantaneous water lines, spring flood levels, etc. Also, the prominent bench marks, with their elevations and the principal results of the tide and river gauging operations of 1887-88, etc. Horizontal scale,  $\frac{1}{48000}$ , or 4 000 ft. per inch. Vertical scale,  $\frac{1}{160}$ , or 16 ft. per inch.
- XXV.—Typical local tide curves at the eight gauging stations between Quebec and Three Rivers, for the low and high water seasons. Scales : abscissas, 1 inch per hour ; ordinates, or heights of water,  $\frac{1}{2}$  inch per foot. Also, hourly instantaneous water lines, Quebec to Lake St. Peter, for the low and high water seasons. Horizontal scale, 5 miles per inch ; vertical,  $\frac{1}{2}$  inch per foot.
- :XXVI.—Admiralty chart No. 2830a, River St. Lawrence, Quebec to Pointe du Lac. General scale, 10 335 ft. nearly. The following additions have been made, in red on this map, viz : (1.) The main continuous line of geodetic levels run along the south shore of the St. Lawrence, together with all check and loop lines, cross-sections, etc., inclusive of river crossings which have been levelled in connection with the main line on both sides of the estuary. (2.) A profile of the ship channel, to a horizontal scale of 30 000 ft. per inch, and a vertical scale of 40 ft. per inch, on which are indicated, besides the characteristic tide levels at high and low stages of the river, the prominent bench marks and principal results of the tidal observations and river gaugings made in 1887-88, the same as on illustration No. XXIV—also, the approximate water line to which the Admiralty soundings appear to have been reduced. (3.) Series of typical local and instantaneous tide curves.
- :XXVII.—Admiralty chart No. 2830 b, River St. Lawrence, Pointe du Lac to Lachine Rapids. General scale, 10 335 ft. per inch nearly. Additions similar to those described for chart No. 2830 a, Illustration No. XXVI., made in red on this map, both in connection with the St. Lawrence and the River Richelieu, including a profile of the whole of the last named river, from Rouse's Point, on Lake Champlain (State of New York) down to Sorel.
- \*XXVIII.—Corresponding tide and current curves at a point in ship channel  $2\frac{1}{2}$  miles below wharf at Point aux Trembles (*en bas*), according to observations made in 1882. Scales : Abscissas, 1 hour per inch ; ordinates, 2 ft. per inch.

\*\* Lithographed one half full size.

† Profile reproduced by lithography  $\frac{3}{16}$  of original size. Horizontal scale,  $\frac{1}{72000}$ , or 6250 ft. per inch ; vertical,  $\frac{1}{160}$ , or 25 ft. per inch.

: This chart reproduced by lithography in two parts, numbered XXVIa. and XXVIb. XXVIa. comprises the plan of the River St. Lawrence, Quebec to Pointe du Lac, to a scale of 10 000 ft. per inch, together with a profile of the corresponding portion of the ship channel : horizontal scale, 30 000 ft. per inch ; vertical, 40 ft. per inch. On XXVIb. are shown the local and hourly instantaneous tide curves, to which is added a table of the main results of the tidal observations and river gauging made in 1887-88.

: This chart also lithographed, inclusive of additions, in two parts, numbered XXVIIa. and XXVIIb. XXVIIa. comprises the plan of the River St. Lawrence to a scale of 10 000 ft. per inch, Pointe du Lac to Montreal and Lachine, together with a profile of the corresponding portion of the ship channel : horizontal scale, 30 000 ft. per inch ; vertical scale, 40 ft. per inch. XXVIIb. is a plan of the whole River Richelieu, Sorel to Rouse's Point, to a scale of 10 000 ft. to an inch, with a profile of the navigable channel drawn to the scales just mentioned.

## REFERENCES TO COLOURS USED ON ILLUSTRATIONS.

*Black* :—1. Plans of Rivers St. Lawrence and Richelieu, according to Admiralty charts, cadastral plans, Quebec Crown Lands Department, etc. 2. Local and instantaneous hourly tide curves for the low water season, as well as all other tide and river level fluctuations observed during the said season, excepting those at Verchères, which are indicated in ultramarine. 3. Loci of discrepancies between observed and computed times of high water, based on Brest times. Black is also used for general illustrating purposes, etc.

*Burnt Sienna* :—Local and instantaneous hourly tide curves for the high water season, as also all other tide and river level fluctuations observed during the said season, excepting the Verchères levels, which are shown in ultramarine.

*Purple* :—Tide and river level fluctuations during winter, or in the spring at the time of the débacle, indicated by purple lines or black lines shaded in purple.

*Ultramarine* :—1. Verchères water levels during the high and low water seasons. 2. Standard low water level proposed for reduction of soundings. 3. Centre line of ship channel, together with mileage and elevations of water surface, also depths of water in same on profile.

*Chinese blue* :—1. Loci of discrepancies between observed and computed times of high water, based on London Bridge times. 2. Theoretical curves of summits and troughs of fluvial waves, and series of gaining and losing tides ; also shading of important water levels of season of navigation.

*Scarlet* :—1. Lines of levels and bench marks indicated on plans. 2. Amended geometrical loci of observed high and low water levels. 3. Loci of proposed provisional corrections of times of high water.

*Jaqueminot lake* :—Current curves and curve of atmospheric pressure or barometric heights.

*Green* :—Ground work of diagrams and profiles and ordinates, abscissas and plans or lines of reference in general.

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**PUBLIC WORKS, CANADA,  
GEODETIC LEVELLING.**

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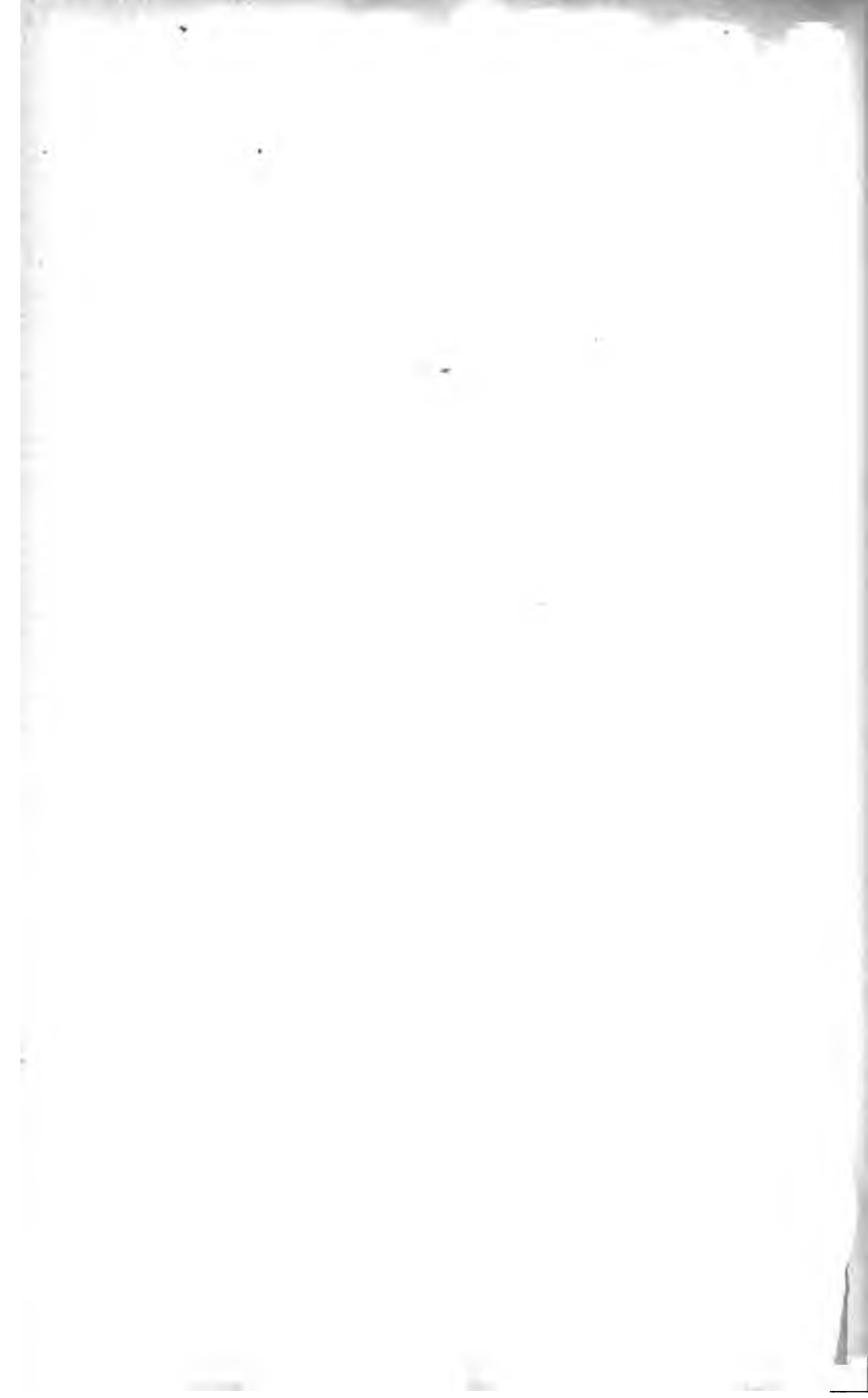
**WATER LEVELS, RIVER ST. LAWRENCE,  
BETWEEN  
QUEBEC, MONTREAL AND LACHINE.**

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**LIST OF APPENDICES TO REPORT ADDRESSED TO CHIEF ENGINEER,  
BY R. STECKEL, ENGINEER IN CHARGE OF LEVELLING AND  
GAUGING OPERATIONS, ETC., UNDER DATE OF 24TH  
NOVEMBER, 1891.**

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WATER LEVELS, ST. LAWRENCE,  
BETWEEN  
QUEBEC, MONTREAL AND LACHINE.

REPORT  
BY R. STECKEL, CIVIL ENGINEER,  
November 24, 1891.

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APPENDIX 13.

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TIDAL FLUCTUATIONS, ETC.,

LEVIS GRAVING DOCK, HARBOUR OF QUEBEC,

DURING A COMPLETE LUNAR MONTH OF THE LOW WATER SEASON  
OF 1887, VIZ., OCTOBER 8 TO NOVEMBER 9.

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TABLE I.

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FIRST WEEK'S SERIES OF GAINING TIDES, No. I.

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## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, Series of gaining tides No. I.

Gauge book reference numbers. Series I	Gaining tides.	DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.													
		High and low waters observed each civil day.		Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide day H.W. to H.W.		Priming — or lagging — of tides.		Duration of apparent stand within 0.05 ft.	
		H.	M.	A.M. or P.M.	H.	M.	H.	M.	H.	M.	Min.	Min.	Feet.	Feet.	Feet.
	Oct. 11 H.W.	1	30	P.M.									11.35		
1	do 11 L.W.	7	30	P.M.			6	50	12	13			1.38	9.30	
2	do 12 H.W.	1	24	A.M.	5	38							13.30	11.30	7.09 11.30
1	do 12 L.W.	9	5	A.M.			7	42	12	57			1.02		12.47
2	do 13 H.W.	2	24	P.M.	5	26							11.38	10.45	6.35 11.37
1	do 13 L.W.	4	35	P.M.			7	4	12	57			0.25		10.34
3	do 14 H.W.	2	30	A.M.	5	13							13.37	12.35	6.51 12.36
1	do 14 L.W.	10	23	A.M.			7	56	12	57			4.42	13.50	
2	do 15 H.W.	3	30	P.M.	5	13							12.1	14.38	6.38 13.37
1	do 15 L.W.	10	22	P.M.			6	4	12	57			0.31		12.02
4	do 16 H.W.	3	43	A.M.	5	12							14.38	14.57	7.306 13.52
1	do 16 L.W.	11	29	A.M.			7	43	12	57			0.26		14.51
2	do 17 H.W.	4	35	P.M.	4	38							14.32	14.16	7.515 14.15
1	do 17 L.W.	11	24	P.M.			7	12	12	57			0.32		13.50
3	do 18 H.W.	4	43	A.M.	4	38							15.36	15.34	7.321 14.31
1	do 18 L.W.	12	25	P.M.			7	42	12	57			1.3		15.34
5	do 19 H.W.	5	12	P.M.	4	37							15.35	15.35	7.178 15.32
1	do 19 L.W.	12	1	A.M.			7	4	12	57			1.4		15.34
3	do 20 H.W.	5	12	A.M.	4	36							15.35	15.34	6.25 15.34
1	do 20 L.W.	1	3	P.M.			7	6	12	57			1.4		15.35
	do 21 H.W.	5	6	P.M.	4	35							15.35	15.34	7.23 15.34
	do 21 L.W.	1	3	A.M.			7	3	12	57			1.4		15.35
4	do 22 H.W.	5	3	A.M.	4	34							15.35	15.34	7.33 15.34
1	do 22 L.W.	1	3	P.M.			7	3	12	57			1.4		15.35
5	do 23 H.W.	5	3	P.M.	4	33							15.35	15.34	7.33 15.34
1	do 23 L.W.	1	3	A.M.			7	3	12	57			1.4		15.35
3	do 24 H.W.	5	3	A.M.	4	32							15.35	15.34	7.33 15.34
1	do 24 L.W.	1	3	P.M.			7	3	12	57			1.4		15.35
5	do 25 H.W.	5	3	P.M.	4	31							15.35	15.34	7.33 15.34
1	do 25 L.W.	1	3	A.M.			7	3	12	57			1.4		15.35
3	do 26 H.W.	5	3	P.M.	4	30							15.35	15.34	7.33 15.34
1	do 26 L.W.	1	3	A.M.			7	3	12	57			1.4		15.35
5	do 27 H.W.	5	3	P.M.	4	29							15.35	15.34	7.33 15.34
1	do 27 L.W.	1	3	A.M.			7	3	12	57			1.4		15.35
3	do 28 H.W.	5	3	P.M.	4	28							15.35	15.34	7.33 15.34
1	do 28 L.W.	1	3	A.M.			7	3	12	57			1.4		15.35
5	do 29 H.W.	5	3	P.M.	4	27							15.35	15.34	7.33 15.34
1	do 29 L.W.	1	3	A.M.			7	3	12	57			1.4		15.35
3	do 30 H.W.	5	3	P.M.	4	26							15.35	15.34	7.33 15.34
1	do 30 L.W.	1	3	A.M.			7	3	12	57			1.4		15.35
5	do 31 H.W.	5	3	P.M.	4	25							15.35	15.34	7.33 15.34
1	do 31 L.W.	1	3	A.M.			7	3	12	57			1.4		15.35

Note. Mean range is whole range minus mean of ebb, and mean of flood, and mean of spring, and mean of neap.

## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, Series of gaining tides No. 1.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).										Wind.		Height of barometric column at sea level and for 0° cent or 32° Fah.	REMARKS.
Diurnal Inequalities.								Lentital intervals.					
In duration of floods. Min.	In duration of ebbs. Min.	In semi tide days. Min.	In high water levels. Feet.	In low water levels. Feet.	In mean tide levels. Feet.	In amplitudes. Feet.	H	M	Velocity miles per hour.	Direction.	Inches.		
...	...	...	2 121	...	147	256	...	...	5 080	N.W.	29 737		
...	51	41	...	0 870	...	...	6	9	2 000	N.W.	29 689		
10	...	...	1 661	...	174	607	...	1	8 590	N.W.	29 762		
...	37	40	...	0 084	...	...	6	38	5	11 367	N.W.	29 779	
3	...	...	1 722	...	084	669	...	...	4 246	N.W.	29 853		
...	41	41	...	0 754	...	...	6	28	4 549	S.W.	29 868		
...	...	...	0 784	...	235	641	...	...	1 026	S.W.	29 747		
...	49	51	...	0 584	...	...	6	58	2 705	N.W.	29 688		
2	...	...	2 069	...	320	735	...	...	3 631	N.W.	29 818		
...	47	35	...	0 680	...	...	6	38	1	2 655	N.W.	29 839	
12	...	...	0 605	...	209	713	...	...	10 250	N.W.	29 974		
...	24	24	...	0 396	...	...	6	22	2	10 500	N.W.	29 979	
...	...	...	1 404	...	116	496	...	5	11 757	N.W.	30 121		
...	22	9	...	0 670	...	...	6	43	4 580	N.W.	30 172		
14	...	...	0 789	...	445	538	...	8	9 858	W.	30 276		
...	1	16	...	0 759	...	...	6	42	3	5 685	W.N.W.	30 239	
13	...	...	0 530	...	329	475	...	...	5 565	W.N.W.	30 231		
...	6	30	...	0 373	...	...	6	27	2 000	W.	30 260		
...	...	...	1 482	...	316	628	...	4	9 735	N.W.	30 050		
...	7	9	...	0 377	...	...	6	30	2	3 430	N.W.	30 082	
...	...	...	0 067	...	720	637	...	...	2 000	S.	30 113		
...	15	2	...	0 426	...	...	6	24	800	W.	30 162		
17	...	...	2 502	...	800	435	...	...	1 525	W.	30 101		
...	13	6	...	0 738	...	...	6	20	2	4 352	N.E.	30 031	
7	...	...	1 024	...	304	024	...	10	4 000	E.	29 885		
...	18	18	...	0 154	...	...	6	21	345	S.E.	29 760		
...	...	...	0 809	...	267	144	...	...	3 200	N.W.	29 868		
...	25	16	...	0 235	...	...	6	51	2 500	N.W.	29 987		
115	136	328	17 589	7 090	4 466	6 998	91	15	139 931	...	839 071		
...	...	...	1 256	0 506	0 319	0 499	6	31	4 998	...	29 967		

## APPENDIX 13.—Tidal Fluctuations. Lévis Graving Dock, series of gaining tides No. I.

RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."																											
(Large book reference numbers, Series I.)	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.				Eastern standard civil times of high water at Québec, based on first times: (No. 2), †		Length of half tide from H. W. to H. W.		Printing or lagging of tides.	Lunitald interval.		Coefficients.	General coefficients of semi-amplitude from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old, together with proportional amplitudes and diurnal inequalities.*														
	Upper passage.		Lower passage.		Ages, &c.	H.	M.	Days.		H.	M.		Co-efficients.	*Ampli-tudes.	Diurnal Difference.												
	H. M.		H. M.											Feet.	In ampli-tudes.												
	H. M.		H. M.												In semi-tide days.												
1																											
2			7	15	(1)	1	24								0 00												
3					3	12	51																				
4															0 57												
5	7	43			5	1	11								7 98	4											
6															0 95												
7																											
8															5 94	4											
9					8	1	11								1 34												
10	8	38																									
11															1 52												
12			9	5											11 96	4											
13					12	1	12								1 71												
14	9	23													13 51	3											
15															1 71												
16															15 22	1											
17					8	1	12								1 72												
18	10	28													16 94	2											
19															1 52												
20															18 46	1											
21					12	1	12								1 33												
22	11	28													19 79	0											
23															1 14												
24			11	34											20 93	0											
25															0 76												
26															21 69	1											
27															0 38												
28															22 07	1											
29															0 20												
30	1	10													22 27	1											
Totals	19	20	38	1																							
14 tides	24	0	12	0											217 31	14 65											
Means	14	10	20	10	1										15 52	1 06											

\* The ratio of the mean of the observed amplitudes to the mean of the coefficients was taken as the basis of computation, viz. say 1909 ft. for 100.

† N.B.—The time of H. W. No. 1, entered in column C, is that found in the tide tables for the port of Québec, and every year by Alexander McCallum at his depot of nautical instruments and charts, 65 St. Francis, Québec. The second time No. 2, is based on times of high water for the port of Boston, from the "Annuaire des Marées de France." The third or time No. 3, is based on the London Bridge nautical Almanac.

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## APPENDIX 13.

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TIDAL FLUCTUATIONS, ETC.,

### LEVIS GRAVING DOCK, HARBOUR OF QUEBEC.

DURING A COMPLETE LUNAR MONTH OF THE LOW WATER SEASON  
OF 1887, VIZ., OCTOBER 8 TO NOVEMBER 9.

Maximum indicated by an asterisk, thus : \* Minimum by a circle, thus : "

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### TABLE I.

WEEKLY SERIES OF LOSING TIDES, No. II.

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## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of losing tides No. I

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).												Wind.		Height of barometric col- umn, at sea-level and for 0° cent. or 32° Fah.	REMARKS.
Diurnal Inequalities.								Lunital intervals.		Oscillations of float in hundredths of a foot.	Velocity miles per hour.				
In duration of floods. Min.	In duration of ebb. Min.	In semi tide days. Min.	In high water levels. Feet.	In low water levels. Feet.	In mean tide levels. Feet.	In amplitudes. Feet.		H	M			Inches.			
9			1.948								985	E.	28.910	Fair, clear weather.....	
25	14		0.000	217	200	6	5			1.256	N.W.	30.080	do .....	9	
11			1.818								653	N.W.	30.117	.....	
23	20		0.100	039	177	5	49			504	N.E.	30.073	Clear, cold weather...		
5			2.197								1.300	N.E.	30.123	Freezing hard.....	
23	18		0.419	024	471	5	54			1.254	N.	30.106	Clear and bright. ....	10	
19			1.728							2	1.500	E.	29.930	.....	
32	20		0.025	053	501	5	41			4.180	N.E.	29.903	Clear weather.....		
12			2.473							5	2.500	N.E.	29.817	.....	
34	24		0.500	030	504	5	49			2	3.287	E.	29.595	Rain .....	11
10			2.333							5	1.338	N.E.	29.392	Raining hard, cold. ....	
33	6		0.245	184	713	5	33			1	1.570	N.E.	29.241	Raining.....	
39			4.356							15	6.380	N.W.	29.435	Moon's S declination a maximum—20° 8'. Max. inequality observed in high water levels = 4.356 feet. Cold wind	
31	34		0.429	851	1.230	5	12			6	3.910	N.W.	29.367	Cloudy and cold. ....	12
65			0.110							6	15.000	N.W.	29.693	Maximum inequality in priming and lagging of tides observed = —32 + 53 Cold.	
43	23		1.041	1.110	0.750	5	25			4	16.500	N.W.	29.875	Sky overcast, very cold.....	
29			1.803							4	15.400	N.W.	30.100	do .....	
68	64		1.450	034	477	6	1			2	7.200	N.W.	30.222	Maximum inequality observed in low water levels = 14.50. Cloudy and cold.	
4			2.406								621	N.W.	30.090	.....	
51	66		0.150	554	490	5	34			1	3.800	N.E.	29.500	Moon's first quarter, Quebec, Oct. 23rd from 0.46 P.M.	
15			1.771							6	3.560	N.E.	29.520	Heavy rain.....	
43	27		0.083	93	253	6	14			1	6.320	N.W.	29.614	Getting colder.....	14
16			0.259							6	15.440	N.W.	29.919	Cloudy and cold. ....	
28	1		1.046	847	566	6	28			3	10.000	N.W.	30.113	Very cold, freezing hard.....	
29			3.266							3	15.850	N.W.	30.180	Fine, clear weather.....	
41	4		0.025	642	263	6	41				3.000	N.W.	30.185	.....	15
51			3.176							2	3.570	N.W.	30.119	Cold, cloudy weather.....	
294	435	321	29.644	5.603	4.678	6.595	76	26			149.360		306.299		
21	37	25	2.117	0.431	0.359	0.507	5	53			5.334		29.863		

## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of losing tides No. II.

Change book reference numbers. Series II. Losing tides.	RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."															
	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.					Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)†		Length of half tide day H. W. to H. W.		Priming—or lagging—of tides.	Lunital intervals.		General coefficients of semi-amplitude from "L'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old, together with proportional amplitudes and diurnal inequalities.*			
	Upper passage.		Lower passage.		Ages, &c.	H. M.		H. M.			H. M.		Co-efficients.	*Ampli- tudes.	Diurnal Differences	
	H.	M.	H.	M.											In ampli- tudes.	In semi- tide days.
	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.		Feet.	Feet.	Min.
1										7						
2						(1) 7	37	12	21						20	
3			1	45	(2) 8	54	12	22		6	9	115	22.07		1	
4					(3) 8	12	12	12	22						57	
5	2	15			8	16	12	22		6	6	1	113	21.50		0
6					8	24	12	22							95	
10			2	44	8	21	12	22			5	54	108	20.55		1
11					8	38	12	21							1 35	
12	3	13			8	45	12	21		7	5	45	101	19.22		1
13					8	50	12	22							1 25	
14			3	41	9	30	12	22			5	40	94	17.80		0
15					9	35	12	22							1 52	
16	4	9			9	43	12	22		5	5	34	86	16.37		1
17					9	50	12	23							1 72	
18			4	36	10	6	12	25			5	30	77	14.65		2
19					10	14	12	25							1 71	
20	5	3			10	31	12	25		2	0	28	68	12.94		3
21					10	39	12	25							1 52	
22			5	30	11	1	12	30			5	28	60	11.42		3
23					11	8	12	30							1 52	
24	5	36			11	26	12	34		14	5	32	52	9.90		4
25					11	36	12	34							1 15	
26			6	21	12	2	12	40			5	41	46	8.75		0
27					12	47	12	44							95	
28	6	45			12	12	12	44		34	5	57	41	7.80		4
29					12	17	12	44							98	
30			7	9	12	24	12	44		6	17	39	7.42		3	
31					12	32	12	47							99	
Totals	27	21	31	46	126	4	174	40	90	74	57	1,001	190.48	15.04	28	
Mean	4	34	4	32	134	4	10	19	12	29	5	77	18.60	1.07	2	

\*The ratio of the mean of the observed amplitudes to the mean of the coefficients being taken as the basis of computation, viz.: say 19.08 ft. = 100.

†N.B.—The upper computed time of H. W. No. 1, entered in column C, is that found in the tide tables for the port of Quebec, which are issued every year by Archibald McCallum at his depot of nautical instruments and charts, 63 St. Peter street, Quebec. The second or time No. 2, is based on times of high water for the port of Brest, France, taken from "L'Annuaire des Marées de France." The third or time No. 3, is based on the London Bridge times of H. W., contained in the "Nautical Almanac."

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## APPENDIX 13..

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TIDAL FLUCTUATIONS, ETC.,

LEVIS GRAVING DOCK, HARBOUR OF QUEBEC,

DURING A COMPLETE LUNAR MONTH OF THE LOW WATER SEASON  
OF 1887, VIZ., OCTOBER 8 TO NOVEMBER 9.

Maximum indicated by an asterisk, thus: \* Minimum by a circle, thus °

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### TABLE I.

WEEKLY SERIES OF GAINING TIDES, No. III.

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## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of gaining tides No. III.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.

Gauge book reference numbers.		Series III. (Gaining tides.																	
		High and low waters observed each civil day.			Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide day H.W. to H.W.		Priming—or lagging—of tides.	Duration of apparent stand within 0.05 ft.	Elevations of supplies and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean apogytides corrected for diurnal inequalities.
		H.	M.	A. M. or P. M.	H.	M.	H.	M.	H.	M.	H.	M.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	Feet.
	Oct. 25	L. W.	8	44	P. M.								+ 35		— 0.304				
1	do 26	H. W.	2	23	A. M.	5	39						+ 37	25	12 198	12 502		5 510	11 25
1	do 26	L. W.	9	59	A. M.			7	36	12	54			19	0 050		12 148		
16	do 26	H. W.	3	17	P. M.	5	19							27	11 174	11 124		5 880	11 41
1	do 26	L. W.	10	15	P. M.			6	58	12	14			19	— 0.080		11 283		
1	do 27	H. W.	3	31	A. M.	5	16						— 10	24	12 578	12 667		6 212	12 40
1	do 27	L. W.	10	43	A. M.			7	12	12	36			13	0 470		12 108		
17	do 27	H. W.	3	57	P. M.	5	14							26	12 618	12 148		6 545	12 30
1	do 27	L. W.	11	12	P. M.			7	15	12	23			19	0 280		12 356		
1	do 27	H. W.	4	30	A. M.	5	8						— 3	26	13 087	12 427		6 487	12 45
1	do 27	L. W.	11	42	A. M.			7	22	12	24			19	— 0.144		13 231		
18	do 27	H. W.	4	44	P. M.	5	2							18	12 573	13 017		6 504	13 12
1	do 28	L. W.	12	5	A. M.			7	21	12	19			15	0 021		12 832		
1	do 28	H. W.	5	13	A. M.	5	8						6	28	13 432	13 431		7 051	13 47
1	do 28	L. W.	12	6	A. M.			6	53	12	15			18	0 655		12 797		
19	do 28	H. W.	5	28	P. M.	5	22							23	15 285	14 630		7 776	13 76
1	do 29	L. W.	12	40	A. M.			7	12	12	16			19	1 150		14 135		
1	do 29	H. W.	5	44	A. M.	5	4						— 10	21	14 778	13 426		7 812	13 87
1	do 29	L. W.	12	55	P. M.			7	11	12	4			19	0 600		13 976		
20	do 30	H. W.	5	48	P. M.	4	53							20	14 566	13 966		7 178	14 06
1	do 31	L. W.	1	26	A. M.			7	8	12	1			15	— 0.299		14 855		
1	do 31	H. W.	5	49	A. M.	4	23						— 23	22	13 101	13 300		6 446	14 164
1	do 31	L. W.	1	32	P. M.			7	43	12	26			19	— 0.983		14 084		
21	do 31	H. W.	6	15	P. M.	4	43							20	13 347	14 330		6 194	14 186
1	Nov. 1	L. W.	1	14	A. M.			7	30	12	25			14	— 0.419		14 166		
1	do 1	H. W.	6	40	A. M.	4	46						— 11	25	13 387	14 186		6 465	14 253
1	do 1	L. W.	2	6	P. M.			7	26	12	14			17	— 0.504		13 871		
22	do 1	H. W.	6	54	P. M.	4	48							18	14 286	14 790		6 369	14 310
1	do 2	L. W.	2	8	A. M.			7	44	12	21			17	— 1.088		15 354		
1	do 2	H. W.	7	16	A. M.	4	37						— 25	23	12 159	13 227		6 162	14 313
1	do 2	L. W.	3	57	P. M.			7	22	12	4			19	— 0.919		13 978		
23	do 2	H. W.	7	19	P. M.	4	42							21	14 672	15 301		6 509	14 500
		H. W.	84	37									— 37	366	213 330				
Total for tides	L. W.	115	50				80	3 110	32 184	76			— 108	290	— 1 604				
	H. W.												37	23	15 334				
Means do	L. W.						5	0	7	19	12	6	— 15	28	— 0.107	13 453	13 351	6 568	13 38
	H. W.																		

N.B.—  
by a circle

Jurnal month indicated on Tables I, II, III and IV by a star, thus \*, and minus

## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of gaining tides No. III.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).										Wind.	Height of barometric column at sea level and for 0° cent or 32° Fah.	REMARKS.
Diurnal Inequalities.							Lunital intervals.		Oscillations of float in hun- dreds of a foot.			
In duration of floods.	In duration of ebbs.	In semi tide days.	In high water levels.	In low water levels.	In mean tide levels.	In ampli- tudes.				Velocity miles per hour.	Direction.	Inches
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.				
42	21			354	352	326	6	51	2	4 270 N.W.	30 515	Fine, clear frosty weather,.....
21		1 024							3	5 080 N.W.	30 618	Fine weather.....
38	40			139	370	526	7	23		2 450 N.W.	30 547	Clear, bright.....16
2		1 404							2	2 000 N.	30 618	.....
14	12			559	332	246	7	15	2	2 750 N.	30 201	Hard frost.....
2		040							4	2 750 N.E.	30 438	.....
3	3			210	333	313	7	19		2 650 N.E.	30 405	Milder weather.....17
8		409								2 630 N.	30 365	Fine and clear.....
7	1			404	058	498	7	21		2 000 N.W.	30 402	do.....
6		214								950 N.W.	30 234	Clouding up.....
1	5			165	017	274	7	24		2 350 S.W.	30 184	.....18
6		579								1 501 W.	30 179	Cloudy.....
24	14			634	547	235	7	32		1 583 W.	30 079	Fine, clear weather.....
14		1 833							4	9 442 S.E.	29 978	Moon crosses equator Oct. 29th; cloudy, appearance of rain.
19	1			495	725	320	7	26	5	2 440 S.E.	30 048	Moon in apogee, Oct. 29th, at 6 p.m. Snowing hard; strong gusts of wind.
18		709							20	26 231 S.E.	30 150	Blinding snow storm.....
1	12			550	036	128	7	21	3	6 276 S.E.	30 233	Gusts of wind; cold.....
11		010								1 094 S.W.	30 078	Fine.....
27	3			889	634	172	7	4		5 258 N.W.	30 096	Bright and clear sky.....20
30		1 465							2	16 894 N.W.	30 000	Getting cloudy.....
5	25			694	732	117	6	44	2	10 935 N.W.	29 900	Snow squall.....
20		246							2	8 442 N.W.	29 826	Cold and cloudy.....
4	1			164	252	032	6	49	1	5 703 N.W.	29 918	Full moon, Quebec, Oct. 31st, at 4h. 31m. p.m.; cloudy.
3		020							15	2 951 N.W.	30 193	Fine moonlight night.....
13	11			315	271	057	6	52		3 117 N.W.	30 247	Cold, clear day.....
2		919							1	4 594 N.W.	30 227	Cold and clear weather.....
19	7			564	096	057	6	44	1	3 056 N.W.	30 191	Bright, cold day.....22
11		2 127								2 390 N.W.	30 106	.....
22	17			149	207	003	6	42		6 328 N.W.	30 003	Clear sky; cold.....
5		2 513								3 749 N.W.	29 871	Sky clouded up; cold.....
26	22			261	347	276	6	23		2 546 N.W.	29 932	Sky overcast.....23
15	239	186	13 572	6 546	5 309	3 640	113	10		144 420	935 900	.....
16	17	12	0 906	0 409	0 331	0 227	7	4		4 659	30 187	.....



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## APPENDIX 13.

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TIDAL FLUCTUATIONS, ETC.,

LEVIS GRAVING DOCK, HARBOUR OF QUEBEC,

DURING A COMPLETE LUNAR MONTH OF THE LOW WATER SEASON  
OF 1887, VIZ., OCTOBER 8 TO NOVEMBER 9.

Maximum indicated by an asterisk, thus \* Minimum by a circle, thus °

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### TABLE I.

WEEKLY SERIES OF LOSING TIDES, No. IV.

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## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of losing tides No. IV.

(Gauge book reference numbers Series IV. Losing tides.		High and low waters observed each civil day.	Time, Eastern Standard.	DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.												Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.
				Duration of floods.		Duration of ebbs.		Length of half tide day H. W. to H. W.		Priming—or lagging—of tides.	Duration of apparent stand with in 6 1/8 ft.	Elevations of sun-lits and troughs of diurnal tide waves.							
				H.	M.	A. M. or P. M.	H.	M.	H.				M.	Min.	Min.				
1	Nov. 2	3 H. W.	7 19 P. M.																
	do	3 L. W.	3 7 A. M.																
1	do	3 H. W.	7 45 A. M.	4	36					— 13	29	13 78	14 36			7 136	14 514		
1	do	3 L. W.	2 50 P. M.					7	14	12	11		14	0 321		13 367			
24	do	3 H. W.	7 56 P. M.	4	57								13	15 066	15 574		7 533 14 53		
1	do	4 L. W.	3 37 A. M.					7	41	12	19		15	0 211		15 484			
1	do	4 H. W.	8 25 A. M.	4	46						— 23	29	14 067	13 575		7 553	14 14		
1	do	4 L. W.	3 28 P. M.					7	3	11	38		21	1 049		13 038			
25	do	4 H. W.	8 23 P. M.	4	56								21	15 575	14 836		7 656 13 49		
1	do	5 L. W.	4 14 A. M.					7	51	12	30		22	0 271		15 604			
1	do	5 H. W.	9 53 A. M.	4	36						— 16	19	12 78	12 507		7 066	13 51		
1	do	5 L. W.	3 52 P. M.					6	59	12	10		22	0 329		12 458			
26	do	5 H. W.	9 3 P. M.	5	11								19	15 917	13 587		6 573 13 74		
1	do	6 L. W.	4 41 A. M.					7	36	12	41		24	— 0 726		14 655			
1	do	6 H. W.	9 44 A. M.	5	3						— 11	29	11 59	11 998		6 157	12 42		
1	do	6 L. W.	4 31 P. M.					6	47	11	38		19	0 329		10 930			
27	do	6 H. W.	9 42 P. M.	5	11								21	14 677	14 367		6 644 12 25		
1	do	7 L. W.	5 33 A. M.					7	51	12	6		17	0 041		14 636			
1	do	7 H. W.	10 29 A. M.	4	56						— 3	27	11 929	11 746		6 844	12 77		
1	do	7 L. W.	5 19 P. M.					6	50	12	6		18	0 980		10 949			
28	do	7 H. W.	10 35 P. M.	5	16								29	14 907	13 727		6 997 12 54		
1	do	8 L. W.	6 19 A. M.					7	44	12	40		22	0 540		14 067			
1	do	8 H. W.	11 24 A. M.	5	5						— 35	21	11 286	10 756		6 454	12 62		
1	do	8 L. W.	6 32 P. M.					7	9	12	36		21	0 280		11 015			
29	do	9 H. W.	12 0 P. M.	5	28								18	12 909	12 529		5 659 12 09		
1	do	9 L. W.	7 40 A. M.					7	40	12	45		18	— 0 990		13 790			
1	do	9 H. W.	12 45 P. M.	5	5						— 10	29	9 909	10 790		5 206	12 10		
1	do	9 L. W.	8 5 P. M.					7	20	12	15		19	— 0 730		10 530			
30	do	10 H. W.	1 0 A. M.	4	55								29	12 680	13 420		5 553 12 39		
								7	30	12	56		18			13 140			
1	Nov. 10	L. W.	8 30 A. M.											— 0 300					
		H. W.	128 4 )										26	184 348					
Totals 14 tides	L. W.	57 )	70	7	111	4	16	8	— 47	26	1 117			13 214					
Means do	14 H. W.								— 16	21									
	14 L. W.								— 14	29	0 60			13 134	13 279	6 640	13 125		
Grand totals	H. W.				284	19	43	1	730	44	1230	744 677		790 560 802	441 396	268 790	876		
37 tides.	L. W.								— 127	12	107	4 117		13 942					
Grand means	H. W.				4	50	7	38	12	5	— 15	19		13 989	13 835	6 987	13 47		
37 tides.												072							

## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of losing tides No. IV.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).										Lentilal intervals.		Oscillations of float in hundredths of a foot.	Wind.		Height of barometric column at sea level and for 0° cent or 32° Fah.	REMARKS.
Diurnal Inequalities.						Velocity miles per hour.	Direction.									
Min.	In duration of ebb.	In semi tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.	H.	M.				Inches				
1			964		829	025					2 710 W.	30 131	Milder temperature.....			
2	15		979				6	26			5 008 N.W.	30 046	Sky overcast; turning colder.....			
3			1 987		883	084			7		3 038 E.	30 245	do .....			
4	18		110				6	13			2 599 N.E.	30 036	do .....			
5			1 608		252	230			10		3 253 N.E.	29 929	do milder.....			
6	31		838				6	18			4 351 N.E.	29 491	do .....			
7			1 788		127	307			3		8 651 N.E.	29 482	Cold; raining hard.....			
8	32		778				5	51	3		15 994 N.W.	29 705	Cloudy; turning colder.....			
9			3 097		500	451			25		21 792 N.W.	29 802	Cold, piercing wind; freezing hard.....			
10	2		049				5	55	4		20 442 N.W.	29 965	Clear, cold day.....			
11			1 139		688	368			30		20 138 N.W.	30 036	Moon's N declination a maximum = 20° 39'. Temperature +14° Fahrenheit.			
12	31		1 058				5	39			5 413 N.W.	30 134	Sky overcast; milder.....			
13			2 667		221	192					622 N.W.	30 291	Snow flurries; much milder.....			
14	43		1 058				5	54			1 972 S.E.	30 135	Sky overcast.....			
15			3 427		487	054					697 N.E.	30 054	Cloudy but mild.....			
16	4		279				5	26			2 878 N.E.	29 938	Cloudy.....			
17			2 848		204	133					1 617 N.E.	29 834	Fine day; not very cold.....			
18	41		839				5	47			8 522 W.	29 759	Clear and bright.....			
19			2 778		049	401					356 W.	29 762	Clouding up somewhat.....			
20	43		340				5	27			935 W.	29 756	Clear weather.....			
21			3 312		443	285			1		16 351 N.W.	29 708	Moon's last quarter, Quebec, from 0 02 p.m., Nov. 8th; cloudy.			
22	13		260				5	49	4		17 069 N.W.	29 932	Cloudy.....			
23			1 305		795	060			12		15 000 N.W.	30 050	Cloudy weather.....			
24	9		1 270				5	59	3		8 000 S.W.	30 302	Fine day.....			
25			3 000		454	101			6		5 000 S.W.	30 368	Fine and bright day.....			
26	30		260				6	17	2		3 000 S.W.	30 272	Clear weather.....			
27			2 880		348	206			3		2 000 S.W.	30 235	do .....			
28	40		230				6	6			2 000 N.E.	30 075	Clouding up.....			
29			1 080						2		4 000 N.E.	29 807	Cloudy; snow.....			
30	415	34 090	8 348	5 680	2 917	83	7				263 408	869 280				
31	30	2 272	506	405	208	5	56				7 014	29 975				
32	12 4	845	27 587	20 133	20 150	364	38				637 119	3450 450				
33	22	1 637	0 484	0 353	0 353	6	24				5 540	30 004				

## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of losing tides No. IV.

RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES"																
Gauge book reference num- bers. Series IV, Losing tides.	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.					Eastern standard civil times of high water at Quebec, based on Great times: (No. 2). †		Length of half tide day H. W. to H. W.		Priming—or lag- ging—of tides.	Lunital intervals		General coefficients of semi-amplitude from "L'Annuaire des Mares," cor- responding to observed tides assumed to be 45 hours old, together with pro- portional amplitudes and diurnal in- equalities.* See foot notes, tables I. II.			
	Upper passage.		Lower passage.		Ages, &c.	H.	M.	H.	M.		Co- efficients.	*Ampli- tudes.	Diurnal Difference.			
	H.	M.	H.	M.									In ampli- tudes.	In semi- tide days		
															Feet.	Min.
1																
2	1	19			(1)				12	15					1	
3					(3)											
4					(3)				12	16					38	
5			1	43											1	
6									12	15					38	
7	2	7													1	
8									12	16					38	
9			2	42											0	
10									12	16					76	
11	2	34													2	
12									12	15					57	
13			3	24											1	
14									12	17					76	
15	3	50													3	
16									12	19					25	
17			4	16											1	
18									12	21					95	
19	4	42													3	
20									12	24					76	
21			5	8											3	
22									12	25					96	
23	5	5													5	
24									12	27					57	
25			6	1											4	
26									12	28					0	
27	6	9													6	
28									12	28					38	
29			6	4											1	
30									12	29						
Total	36	30	29	38	138				4	7			913	173 13	7 51	2
Mean	3	31	4	17	9				12	24			65 21	12 27	60	2
Grand	171	57	178	58					21	12			41 44	268 56	25 46	2 16
to 8 1/2	36	9	30	9					21	12						
Grand	36	57	214	58					21	12						
to 10 1/2	7								21	12						
Grand									21	12						
to 12 1/2									21	12						
Grand									21	12						

General coefficients of semi-amplitude from "L'Annuaire des Mares," corresponding to observed tides assumed to be 48 hours old, together with proportional amplitudes and diurnal inequalities. \* See foot notes, tables I. II.

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## APPENDIX 13.

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TIDAL FLUCTUATIONS, ETC.,

AT

\*CHAUDIERE, ST. NICHOLAS, PLATON, &c.

DURING THE LUNAR MONTH OF THE LOW WATER SEASON OF 1887,  
OCTOBER 9th TO NOVEMBER 8th.

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TABLES II, III AND IV.

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WEEKLY SERIES OF GAINING AND LOSING  
TIDES Nos. I, II, III, IV.

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\* Chaudière fluctuations are incomplete.



## APPENDIX 13. .

TABLE II.—Tidal Fluctuations at Chaudière during the Low water season of 1887, viz., from quadrature October 9th, to quadrature November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."										
Diurnal Inequalities.				Lunital intervals.			Oscillations of float in hundredths of a foot.	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.				Eastern standard civil times of high water at Quebec based on Brest times: No. 2.		Length of half tide day H. W. to H. W.		Priming — or lagging + of tides.	Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.	Series I. (gaining tides). Gauge book reference numbers.
In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.					Upper passage.	Lower passage.	Ages, etc.	Days.	H.	M.	H.	M.					
Feet.	Feet.	Feet.	Feet.	H.	M.			H.	M.											
	280														+34					
1 910	870			6	36			7	16			1	40	12	46		6	24	39	2
1 320	090	200	560	7	3	15		7	43			2	27	12	47	+40	6	44	42	
1 450	700	102	585	6	52					8	11		3	10	12	48		6	59	47
620	227	555		7	15			8	38			3	49	12	39	+22	7	11	54	
1 410	600	285	660	6	54	7				9	6	26	4	22	12	33		7	16	62
540	174	665		7	12	5		9	33			4	51	12	29	+5	7	18	71	
1 300	370	093	470	7	3	4				10	0	27	5	17	12	26		7	17	80
750	650	428	543	7	1			10	28			5	42	12	25	-2	7	14	89	
430	750	344	482	6	49	15				10	56	28	6	5	12	23		7	9	97
1 200	420	284	480	6	54	5		11	24			6	27	12	22	-6	7	3	104	
130	510	693	417	6	48					11	52	29	6	49	12	22		6	57	110
2 150	460	763	333	6	43	20							7	11	12	22	-7	6	51	114
720	730	312	074	6	37	3					48	0	7	32	12	21		6	44	116
690	180	227	055	6	21	3		1	17			1	7	54	15	22	-7	6	37	117
								49	23	58	9				+67					
15 220	7 300	4 132		96	8			+24	0	+12	0		73	16	175	0		97	44	1142
		5 879						73	23	70	9					-22				
																+22				
1 067	0 521	0 318	0 452	6	52			10	29	10	1		5	14	12	30	-6	6	59	81 57
40 712	24 404			367	65														4144	
1 415	0 498			6	45														72 70	

\* Only 27 tides observed at river Chaudière in 1887. Results here given for complete lunar month arrived at by assuming that they are in general directly proportional to corresponding results entered in table I for the Graving Dock station.

## APPENDIX 13.

TABLE III.—Tidal Fluctuations at St. Nicholas during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																					
Gauge book reference numbers. Series I. Tiding tide.	High and low waters observed each civil day.	Time, Eastern Standard.	Duration of floods.		Duration of ebb.	Length of half tide day H. W. to H. W.		Priming or lagging + of tides.		Elevations of sunnites and troughs of fluvial tide waves.	Ranges of floods.		Ranges of ebb.		Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.		Diurnal Inequalities.			
			H. M. or P. M.			H. M. or P. M.		H. M. or P. M.				Feet.		Feet.		Feet.		Min Min			
			H. M. or P. M.			H. M. or P. M.		H. M. or P. M.				Feet.		Feet.		Feet.		Min Min			
Oct. 11	H. W.	1:57 P. M.																			
do	11 L. W.	8:38 P. M.			6:36																
do	12 L. W.	9:40 P. M.			7:34																
do	12 L. W.	9:40 P. M.			7:34																
do	13 L. W.	10:35 P. M.			8:15																
do	13 L. W.	10:35 P. M.			8:15																
do	14 L. W.	11:00 P. M.			8:45																
do	14 L. W.	11:00 P. M.			8:45																
do	15 L. W.	12:02 A. M.			9:15																
do	15 L. W.	12:02 A. M.			9:15																
do	16 L. W.	12:17 A. M.			9:45																
do	16 L. W.	12:17 A. M.			9:45																
do	17 L. W.	1:00 A. M.			10:15																
do	17 L. W.	1:00 A. M.			10:15																
do	18 L. W.	2:00 A. M.			10:45																
do	18 L. W.	2:00 A. M.			10:45																
do	19 L. W.	3:00 A. M.			11:15																
do	19 L. W.	3:00 A. M.			11:15																
do	20 L. W.	4:00 A. M.			11:45																
do	20 L. W.	4:00 A. M.			11:45																
do	21 L. W.	5:00 A. M.			12:15																
do	21 L. W.	5:00 A. M.			12:15																
do	22 L. W.	6:00 A. M.			12:45																
do	22 L. W.	6:00 A. M.			12:45																
do	23 L. W.	7:00 A. M.			1:15																
do	23 L. W.	7:00 A. M.			1:15																
do	24 L. W.	8:00 A. M.			1:45																
do	24 L. W.	8:00 A. M.			1:45																
do	25 L. W.	9:00 A. M.			2:15																
do	25 L. W.	9:00 A. M.			2:15																
do	26 L. W.	10:00 A. M.			2:45																
do	26 L. W.	10:00 A. M.			2:45																
do	27 L. W.	11:00 A. M.			3:15																
do	27 L. W.	11:00 A. M.			3:15																
do	28 L. W.	12:00 P. M.			3:45																
do	28 L. W.	12:00 P. M.			3:45																
do	29 L. W.	1:00 P. M.			4:15																
do	29 L. W.	1:00 P. M.			4:15																
do	30 L. W.	2:00 P. M.			4:45																
do	30 L. W.	2:00 P. M.			4:45																
do	31 L. W.	3:00 P. M.			5:15																
do	31 L. W.	3:00 P. M.			5:15																
do	1 L. W.	4:00 P. M.			5:45																
do	1 L. W.	4:00 P. M.			5:45																
do	2 L. W.	5:00 P. M.			6:15																
do	2 L. W.	5:00 P. M.			6:15																
do	3 L. W.	6:00 P. M.			6:45																
do	3 L. W.	6:00 P. M.			6:45																
do	4 L. W.	7:00 P. M.			7:15																
do	4 L. W.	7:00 P. M.			7:15																
do	5 L. W.	8:00 P. M.			7:45																
do	5 L. W.	8:00 P. M.			7:45																
do	6 L. W.	9:00 P. M.			8:15																
do	6 L. W.	9:00 P. M.			8:15																
do	7 L. W.	10:00 P. M.			8:45																
do	7 L. W.	10:00 P. M.			8:45																
do	8 L. W.	11:00 P. M.			9:15																
do	8 L. W.	11:00 P. M.			9:15																
do	9 L. W.	12:00 A. M.			9:45																
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do	15 L. W.	6:00 A. M.			12:45																
do	16 L. W.	7:00 A. M.			1:15																
do	16 L. W.	7:00 A. M.			1:15																
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do	22 L. W.	1:00 P. M.			4:15																
do	23 L. W.	2:00 P. M.			4:45																
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do	24 L. W.	3:00 P. M.			5:15																
do	24 L. W.	3:00 P. M.			5:15																
do	25 L. W.	4:00 P. M.			5:45																
do	25 L. W.	4:00 P. M.			5:45																
do	26 L. W.	5:00 P. M.			6:15																
do	26 L. W.	5:00 P. M.			6:15																
do	27 L. W.	6:00 P. M.			6:45																
do	27 L. W.	6:00 P. M.			6:45																
do	28 L. W.	7:00 P. M.			7:15																
do	28 L. W.	7:00 P. M.			7:15																
do	29 L. W.	8:00 P. M.			7:45																
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do	30 L. W.	9:00 P. M.			8:15																
do	30 L. W.	9:00 P. M.			8:15																
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do	3 L. W.	1:00 A. M.			10:15																
do	4 L. W.	2:00 A. M.			10:45																
do	4 L. W.	2:00 A. M.			10:45																
do	5 L. W.	3:00 A. M.			11:15																
do	5 L. W.	3:00 A. M.			11:15						</										

## APPENDIX 13.

TABLE III.—Tidal Fluctuations at St. Nicholas during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).						RESULT BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
Diurnal Inequalities.				Lunital intervals.		Oscillations of float in hundredths of a foot.	Eastern standard civil times of meridian passages immediately pre- ceding observed high waters, with corresponding ages and phases of the moon.					Eastern standard civil times of high water at Quebec, based on Brest times: No. 54				Length of half tide day H.W. to H.W.		Priming — or lagging + of tides.	Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Mers," cor- responding to observed tides assum- ed to be 48 hours old.	Series I. Gaining tides. Gauge book reference numbers.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.				Upper passage.	Lower passage.	Ages, etc.	H.	M.	H.	M.	Days.	H.	M.	H.						M.	Min.	H.	M.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														



## APPENDIX 13.

TABLE III.—Tidal Fluctuations at St. Nicholas during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."														
Diurnal Inequalities.					Limital intervals.		Oscillations of float in hundredths of a foot.			Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2).		Length of half tide-day H. W. to H. W.		Priming + or lagging—of tides		Limital intervals.		General coefficients of semi-amplitude from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.		Series II. Losing tides, Gauge book reference numbers.	
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.						Upper passage.	Lower passage.	Ages, etc.												
Min.	Feet.	Ft.	Feet.	Feet.	H.	M.			H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.				
		17																7						
	1 32	07	19	14	6	30				1	46		2 8	8	27	12 21			6 41	116			9	
17	1 39	18	07	03	6	26			2	15				8	42	12 22		6	6 34	113				
19	94	33	14	23	6	32				2	44			9	11	12 22			6 27	108			10	
25	63	04	14	56	6	13			3	13				9	32	12 21		7	6 19	101				
32	2 02	76	00	71	6	27				3	41			9	54	12 22			6 13	94			11	
38	2 00	50	17	62	6	3			4	9				10	16	12 23		5	6 7	86				
44	3 91	61	1 01	90	5	50				4	37			10	39	12 23			6 2	77			12	
49	03	1 14	1 12	49	5	59			5	4				11	4	12 25		2	6 0	68				
49	1 48	06	32	6	47					5	31	O		11	31	12 27			6 0	60			13	
85	2 12	38	63	44	6	12			5	56				12	1	12 30		14	6 5	52				
77	1 14	23	01	16	6	54	25			6	21			12	35	12 34			6 14	46			14	
87	20	1 04	88	50	6	39			6	46				1	15	12 40		34	6 29	41				
55	2 96	08	73	35	7	21			7	9				1	59	12 44			6 50	39			15	
55	2 46		29	16								8 8				12 47								
321	22 80	6 86	5 44	5 61	84	2	27	23	31	49			117	13				50						
													24	0	174	40			82	1	1001			
													141	13					18					
41	1 63	0 49	0 380	0 400	6	28	4	34	4	32			10	52	12 29			17						
																		6	6 19	77 00				



## \*APPENDIX 13.

TABLE III.—Tidal Fluctuations at St. Nicholas during the Low water season of 1887,  
viz :—from quadrature, October 9th, to quadrature, November 8th.

[illegible]

## APPENDIX 13.

TABLE III.—Tidal Fluctuations at St. Nicholas during the Low water season of 1887.  
viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.														
Gauge book reference numbers. Series IV. Losing tides.	High and low waters observed each civil day.	Time. Eastern Standard.	Duration of floods.	Duration of ebbs.	Length of half tide day H. W. to H. W.	Priming or lagging of tide.	Duration of apparent stand within 0.05 feet.	Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	Diurnal In-equalities	
													In duration of floods.	In duration of ebbs.
			H. M. OF P.M.	H. M.	H. M.	H. M.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	Min.	Min.
	Nov. 2 H. W.	8 0 P.M.					19	14 77						
	do 3 L.W.	3 41 A.M.		7 41	12 25		18	0 15		14 92			16	
	do 3 H.W.	8 25 A.M.	4 44			24	11	13 94	14 09		7 26	14 64	36	
	do 3 L.W.	3 30 P.M.		7 5	11 57		15	0 02		13 92			8	
	do 3 H.W.	8 22 P.M.	4 52				23	15 67	15 65		7 26	14 63	34	
	do 4 L.W.	4 1 A.M.		7 39	12 43		10	1 07		14 60			12	
	do 4 H.W.	9 5 A.M.	5 4			9	20	15 39	14 32		8 34	14 47	44	
	do 4 L.W.	4 0 P.M.		6 55	11 58		20	1 12		14 27			1	
	do 4 H.W.	9 3 P.M.	5 3				11	15 84	14 72		8 13	13 89	44	
	do 5 L.W.	4 42 A.M.		7 39	12 24		20	1 24		14 60			18	
	do 5 H.W.	9 27 A.M.	4 45			23	23	13 23	11 99		7 57	13 07	36	
	do 5 L.W.	4 30 P.M.		7 3	12 3		14	0 82		12 41			15	
	do 5 H.W.	9 30 P.M.	5 0				36	14 13	13 31		7 08	12 49	42	
	do 6 L.W.	5 15 A.M.		7 45	12 40		23	0 84		13 29			5	
	do 6 H.W.	10 10 A.M.	4 55			3	19	11 80	10 96		7 01	12 24	35	
	do 6 L.W.	5 0 P.M.		6 50	12 7		14	0 94		10 86			22	
	do 6 H.W.	10 17 P.M.	5 17				26	14 77	13 83		7 15	12 56	61	
	do 7 L.W.	6 8 A.M.		7 51	12 43		4	0 80		13 97			25	
	do 7 H.W.	11 0 A.M.	4 52			2	25	12 38	11 58		7 38	12 43	64	
	do 7 L.W.	5 47 P.M.		6 47	12 5		15	1 52		10 86			26	
	do 7 H.W.	11 5 P.M.	5 18				23	14 81	13 29		7 41	12 12	65	
	do 8 L.W.	6 57 A.M.		7 52	12 53		18	1 18		13 63			17	
	do 8 H.W.	11 58 A.M.	5 1			50	28	11 88	10 70		7 03	11 74	45	
	do 8 L.W.	7 5 P.M.		7 7	12 47		21	1 12		10 76			39	
	do 9 H.W.	12 45 A.M.	5 40				20	13 00	11 82		6 23	11 49	16	
	do 9 L.W.	8 8 A.M.		7 23	12 30		19	0 15		13 15			33	
	do 9 H.W.	1 15 P.M.	5 7			1	25	10 04	10 19		5 65	11 47	2	
	do 9 L.W.	8 40 P.M.		7 25	12 19		19	0 02		10 06			13	
	do 10 H.W.	1 34 A.M.	4 54				25	12 44	12 46		5 91	11 75	7	
	do 10 L.W.	9 6 A.M.		7 32	12 53		20			12 30			27	
								0 14						
			123 56											
			12 0				50	315 180 32						
	Totals 14 tides.		135 56	70 32	110 34	186 27			178 97	198 60	100 01	178 99	277 351	
			77 24				66	250 10 35						
	14 H.W.						50	21 13 323						
	Means do			5 3	7 23	12 26			12 78	12 91	7 144	12 786	19 39	
	14 L.W.						11	18 0 739						
							201	1229 808 76						
	Grand totals 57 tides.			284 45	430 44	720 30			763 89	775 78	426 06	764 55	800 176	
							213	1016 44 87						
	57 H.W.						17	19 14 189						
	Grand means do			5 0	7 26	12 25			13 40	13 38	7 474	13 413	14 31	
	57 L.W.						13	18 0 787						

N.B.—Maxima

south indicated by a star thus: \*, and minima by a circle, thus: °.

## APPENDIX 13.

TABLE III.—Tidal Fluctuations at St. Nicholas during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF  
TIDAL OBSERVATIONS—(Continued).

RESULTS BASED ON DATA FROM  
NAUTICAL ALMANAC  
AND "L'ANNUAIRE DES MARÉES."

Diurnal Inequalities.	Lunital intervals.	Oscillations of float in hundredths of a foot.		Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.		Eastern standard civil times of high water at Quebec, based on Brest times. (No. 2.)		Length of half tide-day H. W. to H. W.		Priming—or lagging—of tides		Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Mers," corresponding to observed tides assumed to be 48 hours old.		Series IV. Losing tides. Gauge book reference numbers.
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.	Upper passage.	Lower passage.	Ages, etc.	Days.	H.	M.	H.	M.	Min.	H.	M.	
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	Days.		H.	M.	H.	M.	Min.	H.	M.	
		00														
28	83	17	32	34	7 5	1	20				8 25	12 15	— 19	7 5	86	
40	1 73	1 05	60	01	6 38	1	44	17 8			8 41	12 16		6 57	84	24
43	28	05	48	16	6 57	2	8	18 8			8 56	12 15	— 19	6 48	82	
26	45	12	21	58	6 30	2	33	9 12			9 12	12 16		6 39	80	25
21	2 61	42	56	82	6 28	16	2 59	9 28			9 28	12 16	— 16	6 29	76	
37	90	02	49	58	6 6	3	24	19 8			9 46	12 18		6 22	73	26
33	2 33	10	67	25	6 20	3	50	20 8			10 3	12 17	— 13	6 13	69	
36	2 97	14	14	32	6 1	4	16	10 23			10 23	12 20		6 7	64	27
38	2 39	23	23	13	6 17	4	43	21 8			10 44	12 21	— 5	6 1	59	
48	2 43	03	03	31	5 56	5	9	11 8			11 8	12 24		5 59	55	28
6	2 93	34	38	38	6 22	5	36	11 35			11 35	12 27	+ 9	5 59	50	
17	1 12	06	80	25	6 43	6	2	12 7			12 7	12 32		6 5	47	29
11	2 96	13	58	02	6 46	6	29	23 8			12 43	12 36	+ 28	6 14	44	
34	2 40	26	28	28	6 39	6	55	24 8			1 25	12 42		6 30	44	30
	13											12 43				
426	26 46	4 75	5 15	4 43	90 48	27	5 30	3			134 36		+ 37	89 28	913	
30	1 764	6 316	0 367	0 316	6 29	3	52	4 18			146 36		— 72			
													+ 18	6 23	65 21	
1348	74 94	25 34	19 67	19 13	396 21	208	20 215	20					— 14			
													+ 210	395 40	4144	
													— 197			
24	1 29	44	34	34	6 57	7	26	7 26			8 4	12 26	+ 19	6 56	72 70	
													— 12			

\* Moon's N. declination a maximum = 20°—39°. † Moon's last quarter, Quebec, from 0° 02 p.m., Nov. 8th.



## APPENDIX 13.

TABLE IV.—Tidal Fluctuations at Pointe Platon during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."																		
Diurnal Inequalities.										Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.																		
					Lunital intervals.		Oscillations of float in hundredths of a foot.							Upper passage.					Lower passage.					Ages, etc.				
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.																								
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Days.
		029																										
32	1 629	646			7	49								7	18			3	1			12 46						
29	1 444	003	135	378	8	16			7	46			25 1	3	48			* 12 47			+ 40	8 2	42					
	1 475		070	303	8	15					8	13		4	31			12 43										
40	620	295	241	350	8	38			8	41			26 1	5	10			12 39			+ 22	8 29	54					
31	1 435	320	223	409	8	22	6				9	8		5	43			12 33					8 35	62				
22	425	188	143	417	8	36	4				9	36		6	12			12 29			+ 5	8 36	71					
9	818	170	119	220	8	29					10	3		6	38			12 26					8 35	80				
5	293	373	159	226	8	21			10	31			28 1	7	3			12 25			— 2	8 32	89					
0	415	380	206	339	8	18	3				10	59		7	26			12 23					8 27	97				
5	975	233	361		8	16	12				11	26	●	7	48			12 22			— 6	8 22	104					
12	120	635	478		8	18					11	54		8	10			12 22					8 16	110				
4	2 083	808	749	278	8	8			22				0 8	8	32			12 22			— 7	8 10	114					
10	738	318	093		7	53						51		8	53			12 21					8 2	116				
5	489	189	160		7	49			1	19			1 8	9	15			12 22			— 7	7 56	* 117					
229	12 360	4 345	3 420	4 072	115	28			49	41	58	26		92	10	175	0	+ 67					116	3	1142			
									+ 24	+ 0	12	0						— 22										
									— 73	— 41	70	26																
16	0 925	0 310	0 263	0 313	8	15			10	32	10	4		6	35	12	30	+ 22					8 17	81	57			
																		— 6										



## APPENDIX 13.

TABLE IV.—Tidal Fluctuations at Pointe Platon during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."																			
Diurnal Inequalities.							Lunital intervals.		Oscillations of float in hundredths of a foot.	Upper passage.				Lower passage.	Ages, etc.	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.		Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)		Length of half tide day H. W. to H. W.		Priming—or lagging + of tides		Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Mers," corresponding to observed tides assumed to be 48 hours old.		Series II. Losing tides.	
In duration of floods.	In duration of ebb.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.	H.	M.		H.	M.	H.	M.	Days.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.																							
9	22	18	1 300	028	*1 153	134	7	48			1	48					9 36	12 21			7 48	116							9
10	21	15	1 246	190	015	132	7	35		2	17			2 8			9 58	12 22			6 41	113							
6	31	23	1 395	815	052	271	7	37	4		2	46					10 20	12 22			7 34	108							10
8	42	30	1 208	077	043	195	7	16	9	3	15			3 8			10 41	12 21			7 26	101							
12	44	28	1 583	567	067	356	7	26	1		3	43					11 3	12 22			7 20	94							11
16	45	12	1 515	520	258	563	7	7	5	4	12			4 8			11 25	12 22			7 13	86							
33	44	14	*3 605		1 087	* 619	07	2	3		4	39					11 48	12 23			7 9	77							12
*38	49	32	110	955	1 092	193	7	11	3		5	6					12 13	12 25			7 7	68							
17	*78	69	1 370	900	074	094	7	52	0		5	33	☉				12 13	12 27			7 7	60							13
9	56	52	2 145	525	502	419	7	25	* 60	5	59			6 8			1 10	12 30			+14	7 11	52						
4	27	26	745	635	168	228	7	52	14								1 44	12 34			7 21	46							14
1	43	25	210	880	864	212	7	52	6	48				7 8			2 24	12 40			+34	7 36	41						
18	62	52	2 550	230	551	* 008	8	18			7	12					3 8	12 44			7 56	39							15
47			2 703		363	261			1					8 8				12 47											
248	644	696	21 684	7 499	6 289	3 685	98	21		27	37	32	4				108 10												
																	+48 0												
																	156 10	174	40		+50	96	29	1001					
																					-18								
18	50	53	1 549	0 536	0 449	0 263	7	34		4	36	4	35				12	1	12	29		+17	7	25	77	00			
																					-6								

Series II. Losing tides.  
Gauge book reference numbers.



## APPENDIX 13.

TABLE IV.—Tidal Fluctuations at Pointe Platon during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."																
Diurnal Inequalities.							Lunital intervals. Oscillations of float in hundredths of a foot.			Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)		Length of half tide day H. W. to H. W.		Priming—or lagging + of tides		Lunital intervals.			General coefficients of semi-amplitudes from "l'Annuaire des Mares," corresponding to observed tides assumed to be 48 hours old.		Series III. Gaining tides. Gauge book reference numbers.		
In duration of floods.	In duration of ebbes.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.				Upper passage.	Lower passage.	Ages, etc.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.		
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.																		
15	40	15		695			8	30		7	35								+34							
			883		433	152								9 8		3 55	12 41		+38	8 20		40				
20	31		020		351	030			5		7	57			4 36					8 39		12	16			
1	11	6	1 100		351	030				8 19					5 13				+18	8 54		46				
5			145		355	160			25				10 8		12 31					9 3		51	17			
2	2	0		100			8	58			8	41			5 44											
12	5	6	350		010	302									12 27											
1				180			9	2		9 2					6 11				+ 0	9 9		56				
			200		036	120							11 8		12 23											
13	18			130			9	12			9	23			6 34					9 11		61	18			
5			430		455	111									12 21											
16	11	5		670			9	4			9 44				6 55				-10	9 11		65				
22	2		1 385		629	12							12 8		12 19											
24				460			9	1			10	5			7 14					9 9		70	19			
	4	7	430		059	100									12 17											
17			090		527	067				8 56			10 26		7 31				-16	9 5		74				
	19	11		678			8	44			10	47			7 48					9 1		77	20			
8			1 365		704	088			13						12 16											
10	10	0		820			8	43		11 8					8 4				-19	8 56		80				
	3	0	180		300	120							14 8		12 15											
3			045		100		8	42	2	11	29	⊙			8 19					8 50		83	21			
	11	10		195			8	40		11 51					12 16											
1			650		044	009							15 8		12 14				*20	8 44		85				
	22	12		725			8	28			13				8 49					8 36		86	22			
10			1 540		166	030									1 15											
29	11		085		8 27					36					9 4				-20	8 28		86				
18			1 830		253	210							16 8		1 15											
	22	13					8	15				59			9 19					8 20		86	23			
146 254	147	10 623	5 950	4 510	1 709	140 35				68 41	59 34				113 51	185 24			+56	141 36		1088				
										+12 0	+24 0									-85						
										-80 41	-83 34															
10 16	9	0 708	0 397	0 301	0 114	8 47				10 5	10 27				7 7	12 22			+19	8 51		68 00				
																				-17						



## APPENDIX 13.

TABLE IV.—Tidal Fluctuations at Pointe Platon during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— <i>Continued.</i>										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."										Series IV. Losing tides. Gauge box reference numbers.	
Diurnal Inequalities.						Lunital intervals. Oscillations of float in hundredths of a foot.		Eastern standard civil times of meridian passages immediately preceding observed high waters with corresponding ages and phases of the moon.				Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)		Length of half tide day H. W. to H. W.		Priming—or lagging—of tides		Lunital intervals. General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.			
In duration of ebb.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.			Upper passage.	Lower passage.	Ages, etc.											
Min	Min	Feet.	Feet.	Feet.	Feet.	H.	M	H.	M	Days.	H.	M	H.	M	Min.	H.	M				
			380												— 20						
		690	685	518	030	8	15	4	1	22					9 34	12 15	— 19	8 12	86		
31	23	1	560	440	345	7	51	10					1	46	17 8	12 16		8 4	84	24	
36	35		350	242	164			20								9 50	12 15				
42	81	980	300	239	129	8	2	10	2	10						10 5	12 16	— 19	7 55	82	
56	45	1	045	650		7	31	5			2	35				18 8	12 16		7 46	80	
54	36	2	325	584	197		32									10 21	12 16			25	
			320	538	207	7	44	3	3	1						19 8	12 16	— 16	7 36	76	
		875	550	096	072	7	22				3	26				10 37	12 18		+	73	
43	34	1	995	430	290	7	33	3								10 55	12 17		7 29	26	
57	31	2	590	290	038	7	33	6			3	52				11 12	12 17	— 13	7 20	69	
62	35		190	811	123	7	12				4	19				20 8	12 20				
		2	100	310	222	7	12									11 32	12 21		7 13	64	
56	30	2	120	051	372	7	27				4	45				12 17	12 21	— 5	7 8	59	
56	29	2	790	280	751	7	12	6			5	11				11 53	12 24		7 6	28	
38	12	1	603	662	263	7	25	50	5	38						12 17	12 27		+	55	
		2	450	303	175	7	51	8								12 44	12 27	+	9	50	
21	7		350	200	050	7	49				6	4				22 8	12 32		7 12	29	
		2	450	303	175	7	49				6	31				23 8	12 36			20	
5	10	2	300	200	050	7	49				6	31				1	52	+	28	44	
15	25	1	450			7	38				6	57				2	34	12	42	44	
																24 8	12 43		7 37	30	
374	433	26	303	5	867	5	395	2	387	106	52					126	42		+	37	
																+	36	0	185	58	
																=	162	42		— 72	
41	32	1	754	0	391	0	385	0	171	7	38					11	37	12	24	+	18
																				— 14	
209	1486	71	560	23	661	19	614	11	853	461	16					524	53	721	2	+	210
																				— 197	
32	27	1	234	0	408	0	350	0	212	8	6					7	29	7	28	+	19
																				— 12	

† Moon's N. declination a maximum = 20° 39'. ‡ Moon's last quarter, Quebec, from 9h. 02m. p.m., Nov. 8th.



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## APPENDIX 13.

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TIDAL FLUCTUATIONS, ETC.,

GRONDINES, ST. JEAN DES CHAILLONS AND BATISCAN.

DURING A COMPLETE LUNAR MONTH OF THE LOW WATER SEASON  
OF 1887, VIZ., OCTOBER 8 TO NOVEMBER 9.

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TABLES V, VI AND VII.

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WEEKLY SERIES OF GAINING AND LOSING  
TIDES, Nos. I, II, III, IV.

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## APPENDIX 13.

TABLE V.—Tidal Fluctuations at Grondines during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

[illegible]



## APPENDIX 13.

TABLE V.—Tidal Fluctuations at Grondines during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued.)										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."											
Diurnal Inequalities.					Lunital intervals, Oscillations of float in hundredths of a foot.		Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.					Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)		Length of half tide day H.W. to H.L.		Priming—or lagging + of tides		Lunital intervals, General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.		Series II. Losing tides, Gauge book reference numbers.	
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.			Upper passage.	Lower passage.	Ages, etc.	Days.											
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	Min.	H.	M.				
		0300																			
	8260		0824	0949									12 21								
	8805	1000	0038	0766		8 18			1	49			10 11			8 22		116	9		
12		1690	0089	1421		8 8	2	18			2 8		10 33		6	8 15		113			
16	1 0455		0090			8 10		5	2	47			10 55			8 8		108	10		
	9560		0038	1766		7 57	5	3 15			3 8		12 21			7 52		101			
15	1 2350		0150	2263		8 3		5	3	44			12 22			7 54		94	11		
20	1 1250		2254	5007		7 45	3	4 12			4 8		12 22			7 48		86			
14	2 9180		8919	5568		7 41	10		4	40			12 23			7 43		77	12		
7		0300	1 0060	0192		7 46	3	5 6			5 8		12 25			7 42		68			
30		7960		1562		8 29			5	33			12 27			7 42		60	13		
40	1 2050		3200	2662		8 3	14	5 59			6 8		12 30		14	7 46		52			
60	1 7130		7560			8 38	10		6	24			12 34			7 55		46	14		
46		7160		1328		8 28					7 8		12 40			8 12		41			
32	2 4010		5190	0981		9 10			7	12			12 44		34	8 31		39	15		
46	2 3110		2503	3215							8 8		12 47					4			
42 18	4150	5 1509	4 4823	3 0420	106 36	27	38	32	9			103 37 + 60 0 = 163 37	174 40		+ 50 - 18 + 17 - 6	103 50		1001			
31	1 3154	0 3679	0 3202	0 2173	8 12	4	36	4	36			12 35	12 29			7 59		77 00			



## APPENDIX 13.

TABLE V.—Tidal Fluctuations at Grondines during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRES DES MARÉES."													
Diurnal Inequalities.						Lunital intervals. Oscillations of float in hundredths of a foot.		Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)		Length of half tide day H. W. to H. W.		Priming—or lagging + of tides		Lunital intervals. General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.		Series III. Gaining tides. Gauge book reference numbers.				
In duration of ebb.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.			Upper passage.	Lower passage.	Ages, etc.	H.	M.	H.	M.	Min.	H.				M.			
Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.						
57	27	5770	3819	3271	4124	9	7	7	35	9	8	4	30	12	41	38	8	55	40	16			
34	24	9760	1400	2963	1645	9	32	7	57	5	11	12	37	12	37	18	9	29	46	17			
12	2	1390	5680	3460	0742	9	33	10	8	10	8	5	48	12	31	38	9	38	51	18			
2	2	2790	0500	0798	1195	9	36	8	41	6	19	12	27	12	27	0	9	44	56	19			
7	7	1390	0100	0588	0478	9	38	9	2	11	8	6	46	12	23	9	46	61	18				
9	13	3300	0800	2817	1942	9	47	9	23	7	9	7	9	12	21	10	9	56	65	20			
17	3	9940	2890	4576	1393	9	43	9	44	7	30	12	19	12	19	10	9	44	70	21			
23	3	2090	4870	2200	1070	9	36	10	5	7	49	8	6	12	17	16	9	40	74	22			
2	5	0900	0600	1694	1988	9	30	10	26	13	8	8	6	12	17	16	9	36	77	23			
20	15	10460	2000	4817	00075	9	15	4	10	47	8	23	8	12	16	19	9	36	77	24			
15	2	0600	7560	3633	2385	9	15	11	8	14	8	8	39	12	15	19	9	31	80	25			
1	6	0500	2090	0510	1520	9	13	11	29	14	8	8	54	12	15	16	9	25	83	26			
16	15	1590	0023	0745	0745	9	16	11	51	15	8	9	10	12	16	20	9	19	85	27			
25	6	5480	0800	1322	0248	9	4	12	13	12	13	9	24	12	15	20	9	11	86	28			
26	2	11800	2090	1583	1765	8	57	12	36	16	8	9	39	12	15	20	9	3	86	29			
21	12	13450	1583	1765	1765	8	48	12	59	16	8	9	54	12	15	20	9	55	86	30			
28	144	7 9680	3 6789	3 4255	2 1315	149	50	80	41	83	34	123	11	197	39	56	150	56	1088				
18	9 0	5312	0 2453	0 2284	0 1421	9	22	10	5	10	27	7	42	12	21	17	9	26	68 00				



## APPENDIX 13.

TABLE V.—Tidal Fluctuations at Grondines during the Low water season of 1887,  
viz.:—from quadrature, October 9th, to quadrature, November 8th.

[illegible]

†Moon's N. declination a maximum =  $20^{\circ} 39'$ . ‡Moon's last quarter (Quebec) from 0h. 2m. p.m. Nov. 8.



TABLE VI.—Tidal Fluctuations at St. Jean des Chaillons during the Low water season of 1887, viz.:—from quadrature of Oct. 9th to quadrature of Nov. 8th.

**DIRECT RESULTS OF TIDAL OBSERVATIONS—**  
(Continued.)

**RESULTS BASED ON DATA FROM**  
**NAUTICAL ALMANAC**  
**AND "L'ANNUAIRE DES MAREES."**

Diurnal Inequalities.										Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and places of the moon.															
In duration of floods.	In duration of ebb.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.	Lunital intervals.			Oscillations of float in hundredths of a foot.	Eastern standard civil times of high water at Quebec, based on Best times: (No. 2.)														
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.		Upper passage	Lower passage	Ages, etc.	Days.	H.	M.	H.	M.	Length of half tide day H. W. to H. W.	Priming—or lagging + of tides	Lunital intervals.			General coefficients of semi-amplitudes from "l'Annuaire des Mares," corresponding to observed tides assumed to be 48 hours old.	Series I. Gaining tides. Gauge book reference numbers.	
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.		H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min	H.	M.				
				2449															+34						
			1 2962	0350					2									12 46							
11	43	32	1 1141	0240	0532		8	39										12 47							
	20	35		0401			9	9						7 47		25 1	4 44		+40	8 57					
15			1 1341	0719	2135		9	5										12 43							
	4	28		0298										8 14		5 27				9 13					
24			4397	1405	3309		9	28						26 1				12 39							
	30	31		0200										8 42		6 6			+22	9 24					
1	27	21	9694	1712	2773		9	21										12 33							
	25	23	2597	0850	2130	1862			2					9 9		6 39				9 30					
6			1548				9	34	3					27 1				12 29							
8	17	2	7744	2404	0262		9	25	1									12 26	+ 5	9 31					
			3000																	9 30					
15	18	20	2748	0280	1441		9	17	2					10 32		7 59		12 25	-2	9 27					
			4013	0907	0118													12 23							
12	26	4		0697			9	15						11 0		8 22				9 22					
26			6911	0594	4090													12 22							
	11	10		2203			9	18						11 27		8 44			- 6	9 17					
21			0750	3581	5565													12 22							
	19	12		3800			9	10						11 55		9 6				9 11					
31			1 7040		5705	2957								0 8				12 22							
	2	21		4653			9	14						12 23		9 28			- 7	9 5					
23			6096		2830	1637												12 21							
	8	20		2641			8	56						12 52		9 49				8 57					
12			3197	0328	2883									1 8				12 22							
	19	0					8	59						1 20		10 11			- 7	8 51					
23	26	29	10 0631	2 4090	2 2835	2 9564	128	50	...					61 48	70 33	...	105 14	175 0	+67	128 25		1142			
														+12 0					-22						
														=73 48											
18	19	10	7188	1721	1757	2274	9	12	...					10 33	10 5		7 31	12 30	+22	9 12		81 57			
																			- 6						

APPENDIX 13.

TABLE VI.—Tidal Fluctuations at St. Jean des Chaillons during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Average water whenever summer spring is leaving station.			High and low waters at each civil day.			Time Eastern Standard.			Duration of floods.			Duration of ebbs.			Length of half tide day H.W. to H.W.			Priming or lagging + of tides			Duration of apparent stand within 0.05 feet.			Elevations of summits and troughs of fluvial tide waves.			Ranges of floods.			Ranges of ebbs.			Mean tide levels corrected for diurnal inequalities.			Mean amplitudes corrected for diurnal inequalities.			In duration of floods.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								

## APPENDIX 13.

TABLE VI.—Tidal Fluctuations at St. Jean des Chaillons during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).												RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."																					
Diurnal Inequalities.												Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.																					
In duration of ebb.		In semi-tide days.		In high water levels.		In low water levels.		In mean tide levels.		In amplitudes.		Lunital intervals.		Oscillations of float in hundredths of a foot.		Upper passage.		Lower passage.		Ages, etc.		Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)		Length of half tide day H. W. to H. W.		Priming—or lagging + of tides		Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.		Series II. Lowing tides. Gauge book reference numbers.	
Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.	H.	M.	H.	M.	H.	M.
									</																								



## APPENDIX 13.

TABLE VI.—Tidal Fluctuations at St. Jean des Chaillons during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued.)						RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."															
Diurnal Inequalities.					Lunital intervals.		Oscillations of float in hundredths of a foot.	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)	Length of half tide day H. W. to H. W.	Priming + or lagging—of tides	Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.	Series III. Gaining tides. Gauge book reference numbers.				
In mean tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.				Upper passage.	Lower passage.	Ages, etc.											
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.					
														+ 34							
29		4197			9	19				7	36			4	51	+ 38	9 15	40			
27	5226		2437	1427	9	47						9 8		12	41		9 34	42	16		
2	9276		2890	1483	9	48	1			8	20			6	9	+ 18	9 49	46			
4	1203		3196	0746	9	51						10 8		12	31		9 58	51	17		
	2504		0943	0736	9	51				9	3			12	27	+ 0	10 4	56			
7	1147		0630	0463	9	58						11 8		12	23		10 6	61	18		
12	3147		1387	3922	9	53				9	24			7	30		10 6	65			
8	8244		2354	5608	9	56	1					10 6		7	51	- 10	10 6	70	19		
13	1000		3192	1611	9	46				10	27			8	10		10 4	74			
1	0699		0762	6670	9	37	1					10 27		8	27	- 16	10 0	77	20		
10	9805		4036	2174	9	38				11	9			10	48		9 56	80			
9	0001		3559	3071	9	30						11 30		9	0		9 51	83	21		
1	0201		0013	2223	9	20						11 52		9	15		9 45	85			
8	4799		0087	0623	9	18				11	52			9	31	- 20	9 39	86	22		
1	0294		1036	0226	9	21						12 14		9	45		9 31	86			
5	2298		1012	1874	9	21				12	37			10	0	- 20	9 23	86			
2					9	14						16 8		12	15		9 15	86	23		
138	6 8920	3 3769	2 7534	3 2857	154	7	...			80	49	71 42 + 12 0 - 83 42	...	128	47	185	24	+ 56 - 85 + 19 - 17	156	16	1088
9	4505	2251	1836	2190	9	38	...			10	6	10 28	...	8	3	12 22		9 46	68	00	

## APPENDIX 13.

TABLE VI.—Tidal Fluctuations at St. Jean des Chaillons during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.														
Gauge book reference numbers. Series IV. Tiding tides.	High and low waters observed each civil day.	Time, Eastern Standard.	Duration of floods.		Duration of ebbs.	Length of half tide day H.W. to H.W.	Priming or lagging + of tides		Elevation of summits and troughs of fluvial tide waves.	Ranges of floods.		Ranges of ebbs.		In duration of floods.
			H.	M.	H.	M.	H.	M.		Feet.	Feet.	Feet.	Feet.	
		A.M. P.M.					Min.	Min.						Min.
	Nov 2	H. W.	10 14	P. M.				13		16 0052				
	Nov 3	L. W.	6 26	A. M.		8 12	12 14		35	10 1135				
	do	3 H. W.	10 28	A. M.	4 12			26	34	15 5752	5 4617	5 8917	13 0917	5 7217
	do	3 L. W.	6 25	P. M.		7 57	12 10		34	10 3452		5 1250		
	do	3 H. W.	10 38	P. M.	4 13				35	16 0355	6 3064		13 3852	5 7469
	do	4 L. W.	7 7	A. M.		8 29	12 38		35	10 5752		5 9794		
	do	4 H. W.	11 6	A. M.	3 59			13	34	16 1452	5 4747		13 5886	5 7055
	do	4 L. W.	7 6	P. M.		8 9	11 59		34	10 2752		5 3517		
	do	4 H. W.	11 5	P. M.	3 59				34	16 8152	6 0164		13 5172	5 4179
	do	5 L. W.	7 28	A. M.		8 21	12 32		33	10 8152		5 9964		
	do	5 H. W.	11 43	A. M.	4 17			12	31	15 1352	4 3073		13 1317	5 1069
	do	5 L. W.	7 42	P. M.		7 59	12 24		34	10 3352		4 7871		
	do	6 H. W.	12 7	A. M.	4 13				34	15 1352	5 3382		12 6364	5 0856
	do	6 L. W.	8 16	A. M.		8 2	12 17		34	10 2752		5 2854		
	do	6 H. W.	12 24	P. M.	4 8			12	30	14 4411	4 3923		12 4591	5 2305
	do	6 L. W.	8 3	P. M.		7 52	12 4		35	10 6852		4 4023		
	do	7 H. W.	12 29	A. M.	4 13				31	16 1352	6 3011		12 6814	5 2106
	do	7 L. W.	9 13	A. M.		8 45	12 35		34	10 3152		5 2854		
	do	7 H. W.	1 4	P. M.	3 51			6	34	14 7252	4 3133		12 8235	5 1281
	do	7 L. W.	8 24	P. M.		7 50	12 29		33	10 1352		4 4023		
	do	8 H. W.	1 24	A. M.	4 30				32	16 1752	5 9714		12 7632	4 9647
	do	8 L. W.	10 10	A. M.		8 46	12 38		34	10 3352		5 6671		
	do	8 H. W.	2 0	P. M.	3 50			6	34	13 3352	3 6282		12 3622	4 7074
	do	8 L. W.	10 11	P. M.		8 11	12 29		33	10 2752		4 3076		
	do	9 H. W.	2 50	A. M.	4 20				34	14 2752	3 0350		12 4346	4 2339
	do	9 L. W.	11 10	A. M.		8 20	12 34		34	10 2752		3 7193		
	do	9 H. W.	3 21	P. M.	4 14			5	34	13 2752	3 7193		12 9169	3 7308
	do	10 L. W.	11 32	A. M.		8 59	12 31		34	10 2752		3 7193		
	do	10 H. W.	3 43	A. M.	3 58				34	13 2752	3 6100		12 9421	3 4766
	do	10 L. W.	12 10	P. M.		8 25	12 5		34	10 2752		3 4533		
	do	10 H. W.	10 6	A. M.				2	34	14 2752				
	Totals 14 tides.	130 20			38 20	123 31	12 5			70 0256	54 7516	180 7332	63 4670	316
	do	140 1								27 22 15				
	Mean.	140 1			1 10	8 24	12 20			5 0020	4 9834	12 9086	4 9619	21
	Grd. means do									3 47 20				
	Grd. means do				38 10	83 19	12 24			214 507 84 221				
	do									212 180 840 621				
	do									26 27 15				
	Grd. means do				4 3	8 24	12 25			5 3304	5 2912	13 3012	5 3327	19

N.B. Maxima in which there is an indication of a wave, by a dot, and minima by a circle, thus: 9. Maximum diurnal inequality observed in low water levels: 1.31 ft.

## APPENDIX 13.

TABLE VI.—Tidal Fluctuations at St. Jean des Chaillons during the Low water season of 1887, viz. :—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— <i>Continued.</i>							RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."											
Diurnal Inequalities.						Lunital intervals.		Oscillations of float in hundredths of a foot.	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times : (No. 2.)	Length of half tide day H. W. to H. W.		Priming—or lagging—of tides	Lunital intervals.		General coefficients of semi-amplitudes from "L'Annuaire des Mares," corresponding to observed tides assumed to be 4 hours old.
In duration of ebb.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.				Upper passage.	Lower passage.	Ages, etc.							
Min	Min	Feet.	Feet.	Feet.	Feet.	H.	M.		H.	M.	Days.	H.	M.	H.	M.	Min.	H.	
			2447												20			
15	4	4300	2347	2872	0950	9	05	1	23				10	30	12	15		
32	18	1 0794	2935	0252	9 05	8	51			17	8		12	16	19	9	7	
29	29	5047	3270	2043	0414	8	55		2	11			10	46		8	59	
21	39	6647	1230	0723	2876	8	29	1			18	8	12	15	19	8	50	
22	14	1 6891	0200	3855	3110	8	41	1		2	36		11	17		8	41	
19	7	5497	4798	4953	0213	8	41	1	3	2			11	33	16	8	31	
30	13	1 4341	4896	1773	1449	8	40				19	8	12	18		8	24	
66	32	1 8988	0100	2223	0200	8	31		3	53			12	8	13	8	15	
33	16	1 5141	4747	1512	0824	8	8				20	8	12	20		8	8	
56	16	1 5691	0900	0694	1634	8	18		4	46			12	28		8	3	
35	10	2 2285	1147	4110	2573	8	12			5	12		12	49	5	8	3	
9	44	7294	6794	0824	4735	8	21	3			21	8	1	13		8	1	
8	13	1 3177	4823	5031	8 45	8	45	1			22	8	1	13		8	1	
3	16	1527	1500	0252	2 542	8	52		6	32			2	12		8	7	
		1120	1547			8	47				23	8	2	48		8	16	
		5365							6	58			12	42		8	32	
										24	8		3	30		44		
201	277 15	0928	4 9100	3 3692	2 6803	120	35	27	26	30 25			115 46 + 60 0 =175 46	185 58	+ 37	117 55	913	
28	20	1 0062	3273	2407	1915	8	37	3	55	4 21			12	33	12 24	8 25	65 21	
1578	1145	46 5134	15 7212	12 2158	11 6992	514	59	209	46	216 51			578	6 721	2	511 29	4144	
29	20	8019	2711	2181	2089	9	2	7	30	7 29			10	9	12 26	8 58	72 70	

\*Moon's N. declination a maximum = 20° 39'. †Moon's last quarter (Quebec), from 0h. 02m., p.m. November 8th.

## APPENDIX 13.

TABLE VII.—Tidal Fluctuations at Batiscan during the Low water season of 1887, viz.:—from quadrature of October 9th to quadrature of November 8th.

DIRECT OF RESULTS OF TIDAL OBSERVATIONS, &c.																
Gauge book reference numbers. Series I. Gaining tides.	High and low waters observed each civil day.	Time, Eastern Standard.	Duration of floods.		Duration of ebbs.		Length of half tide day H. W. to L. W.		Priming or lagging + of tides.	Duration of apparent stand within 0.05 feet.	Elevations of summits and troughs of fluvial tide waves.	Range of floods.	Range of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	
			H.	M.	H.	M.	H.	M.								Min
			A.M.	P.M.	H.	M.	H.	M.	Min	Min	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
Oct. 12	L. W.	1 12 A.M.			2 9		12 5	-45		79	13.657		1.570			
do 12	H. W.	4 32 A.M.	3 36		9 2		12 36		25	16.142	2.485		2.416	14.683	2.09	
do 12	L. W.	2 6 P.M.			9 6		12 36		25	13.735			2.416			
do 12	H. W.	5 34 P.M.	3 48		9 6		12 13	-19	40	15.268	1.542			14.675	2.07	
do 13	L. W.	1 0 A.M.			9 6		12 36		25	13.557			1.711			
do 13	H. W.	4 10 A.M.	4 1		9 6		12 36		25	16.152	2.565			14.731	2.19	
do 13	L. W.	2 0 P.M.			9 6		12 36		25	13.706			2.446			
do 13	H. W.	5 12 P.M.	3 35		9 6		12 36	3	21	15.744	2.032			14.870	2.47	
do 14	L. W.	1 13 A.M.			9 6		11 35		22	13.616			2.128			
do 14	H. W.	4 9 A.M.	3 47		9 6		12 45		22	16.082	3.053			15.014	2.77	
do 14	L. W.	2 4 P.M.			9 6		12 45	-13	22	13.826			2.973			
do 14	H. W.	5 17 P.M.	3 47		9 6		12 15		22	16.410	2.714			15.225	2.86	
do 15	L. W.	1 4 A.M.			9 6		12 15		22	13.826			2.544			
do 15	H. W.	4 9 A.M.	3 47		9 6		12 15		22	17.186	3.320			15.454	2.97	
do 15	L. W.	2 5 P.M.			9 6		12 15		22	14.114			3.072			
do 15	H. W.	5 17 P.M.	3 11		9 6		12 45	5	22	16.477	2.713			15.503	2.78	
do 16	L. W.	1 48 A.M.			9 6		12 45		22	14.134			2.753			
do 16	H. W.	4 9 A.M.	3 15		9 6		12 45		22	16.562	2.435			15.401	2.74	
do 16	L. W.	2 6 P.M.			9 6		12 45		22	13.754			2.615			
do 16	H. W.	5 9 P.M.	3 36		9 6		12 17	-1	22	17.034	3.032			15.473	2.99	
do 17	L. W.	1 25 A.M.			9 6		12 17		22	13.824			3.012			
do 17	H. W.	4 9 A.M.	3 13		9 6		12 33		22	17.034	3.311			15.735	3.42	
do 17	L. W.	2 6 P.M.			9 6		12 4	13	22	14.124			3.181			
do 17	H. W.	5 10 P.M.	3 9		9 6		12 4		22	17.034	2.923			16.283	3.72	
do 18	L. W.	1 6 A.M.			9 6		12 51		22	14.124			3.727			
do 18	H. W.	4 10 A.M.	3 19		9 6		12 51		22	17.034	3.618			16.392	3.73	
do 18	L. W.	2 7 P.M.			9 6		12 51		22	14.124			3.628			
do 18	H. W.	5 10 P.M.	3 29		9 6		12 51	4	22	17.034	4.007			16.608	3.67	
Totals 14 tides.		68 45	24 50	49 123	8 173	52	855	145.344	41.326	2.46	216.327	40.351				
Means do.		5 45					61	10.382								
Means do.			3 38	4 47	12 25		22	13.922	2.952	2.703	15.432	2.881				

N.B. Maxima in whole line, marked with a star, thus: \* and minima by a circle, thus: °. The zero of the gauge was taken to be 2° below the datum instead of 25.4662 ft. as per abstract of results.

1) Longland. Barometer. Rainfall. S. wind. 2) 15 0. 3) S.W. wind. 4) 49 in. H. 5) 100 in. S. wind. 6) 100 in. S. wind. 7) 100 in. S. wind. 8) 100 in. S. wind. 9) 100 in. S. wind. 10) 100 in. S. wind. 11) 100 in. S. wind. 12) 100 in. S. wind. 13) 100 in. S. wind. 14) 100 in. S. wind. 15) 100 in. S. wind. 16) 100 in. S. wind. 17) 100 in. S. wind. 18) 100 in. S. wind. 19) 100 in. S. wind. 20) 100 in. S. wind. 21) 100 in. S. wind. 22) 100 in. S. wind. 23) 100 in. S. wind. 24) 100 in. S. wind. 25) 100 in. S. wind. 26) 100 in. S. wind. 27) 100 in. S. wind. 28) 100 in. S. wind. 29) 100 in. S. wind. 30) 100 in. S. wind. 31) 100 in. S. wind. 32) 100 in. S. wind. 33) 100 in. S. wind. 34) 100 in. S. wind. 35) 100 in. S. wind. 36) 100 in. S. wind. 37) 100 in. S. wind. 38) 100 in. S. wind. 39) 100 in. S. wind. 40) 100 in. S. wind. 41) 100 in. S. wind. 42) 100 in. S. wind. 43) 100 in. S. wind. 44) 100 in. S. wind. 45) 100 in. S. wind. 46) 100 in. S. wind. 47) 100 in. S. wind. 48) 100 in. S. wind. 49) 100 in. S. wind. 50) 100 in. S. wind. 51) 100 in. S. wind. 52) 100 in. S. wind. 53) 100 in. S. wind. 54) 100 in. S. wind. 55) 100 in. S. wind. 56) 100 in. S. wind. 57) 100 in. S. wind. 58) 100 in. S. wind. 59) 100 in. S. wind. 60) 100 in. S. wind. 61) 100 in. S. wind. 62) 100 in. S. wind. 63) 100 in. S. wind. 64) 100 in. S. wind. 65) 100 in. S. wind. 66) 100 in. S. wind. 67) 100 in. S. wind. 68) 100 in. S. wind. 69) 100 in. S. wind. 70) 100 in. S. wind. 71) 100 in. S. wind. 72) 100 in. S. wind. 73) 100 in. S. wind. 74) 100 in. S. wind. 75) 100 in. S. wind. 76) 100 in. S. wind. 77) 100 in. S. wind. 78) 100 in. S. wind. 79) 100 in. S. wind. 80) 100 in. S. wind. 81) 100 in. S. wind. 82) 100 in. S. wind. 83) 100 in. S. wind. 84) 100 in. S. wind. 85) 100 in. S. wind. 86) 100 in. S. wind. 87) 100 in. S. wind. 88) 100 in. S. wind. 89) 100 in. S. wind. 90) 100 in. S. wind. 91) 100 in. S. wind. 92) 100 in. S. wind. 93) 100 in. S. wind. 94) 100 in. S. wind. 95) 100 in. S. wind. 96) 100 in. S. wind. 97) 100 in. S. wind. 98) 100 in. S. wind. 99) 100 in. S. wind. 100) 100 in. S. wind.

## APPENDIX 13.

TABLE VII.—Tidal Fluctuations at Batiscan during the Low water season of 1887, viz.:—from quadrature of October 9th to quadrature of November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."																									
Diurnal Inequalities.																																			
In duration of floods		In duration of ebb		In semi-tide days.		In high water levels.		In low water levels.		In mean tide levels.		In amplitudes.		Lunital intervals.		Oscillations of float in hundredths of a foot.		Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)			Length of half tide day H.W. to L.W.		Priming—or lagging: of tides.		Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.		Series I. Gaining tides. Gauge book reference numbers.			
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Days.	H.	M.	Min.	H.	M.	H.	M.	Min.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	
			915																																
59	51		874	069	018	063	9	38	1			7	20			4	42			12	46														
62	43			169			10	7	3		7	47			25	1	5	29	+40		9	42													
19			884		056	130			8								6	12			12	43													
57	45			149			9	52	5		8	15					6	12																	
55	63		408		139	220			1								6	51		+22	10	9													
8			925		144	300															12	33													
61	50			080			9	50	5			9	10			7	24																		
11			259		211	171															12	29													
29	27			170			10	8		9	37					7	53		+5	10	16														
2			776		229	039															12	26													
24	3			248			9	59	1			10	4			8	19				10	15													
27			299		049	169			3							28	1				12	25													
21	25			020			9	46	3	10	32					8	44		-2	10	12														
4			318		102	044															12	23													
23	8			180			9	58	7			11	0			9	7				10	7													
15			437		072	284										29	1				12	22													
17	15			040			10	2		11	28					9	29		-6	10	1														
8			299		322	474															12	22													
20	6			130			9	51				11	56			9	51				9	55													
26			1 202		498	270															12	22													
2	19			596			9	46		12	24					10	13		-7	9	49														
25			169		299	021															12	21													
25	27			020			9	22								10	34				9	42													
2			363		016	096										1	8				12	22													
14	8			149			9	24		1	21					10	56		-7	9	35														
										61	51									+67															
										+12	0																								
163	469	390	8	134	2	110	2	155	2	281	138	6	73	51	70	37	115	44	175	0	139	16	1142												
																				-22															
13	34	28	0	581	0	151	0	166	0	176	9	52	10	33	10	5	8	16	12	30	9	57	81	57											
																				+22															
																				-6															

a Feeble N.W. wind. Fine clear weather.

b Feeble N.W. wind. Fine clear weather.

c Fresh S.W. breeze.

d S.W. wind.

e Moon crosses equator Oct. 16th.

f Stiff S.W. breeze. Clear and cold.

g Moon in perigee, Oct. 15th, at 1 p.m. Strong S.W. wind.

h Wind going down. Appearance of rain. New moon (Quebec) at 5.35 p.m., Oct. 16th.

i Fresh N.E. breeze. Rain at midnight.

r Feeble S.W. wind. Fine.

s S.W. wind, just perceptible. Fine day.

x Gentle N.E. breeze. Clouding up; appearance of rain.

z S.W. wind. Weather clearing up.

aa Wind changes from S. to N.W. Fresh breeze blowing. bb N.W. breeze, just perceptible. Fine clear weather.

cc Most important tide but one during 1887, viz.: evening tide of March 11th, for which coefficient of semi-amplitude is 118. N.W. wind; fine.

## APPENDIX 13.

TABLE VII.—Tidal Fluctuations at Batiscan during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.															
Gauge book reference numbers. Station H. Lower tides.	High and low waters observed each civil day.	Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide day H. W. to H. W.		Priming - or lagging + of tides		Duration of apparent stand within 0.05 feet.		Elevations of summits and troughs of fluvial tide waves.	
		H.	M.	A.M.	P.M.	H.	M.	H.	M.	Min.	Min	Feet.	Feet.	Feet.	Feet.
	Oct. 18 H. W.	10	41	P.M.						4				18	707
10	do Oct. 19 L. W.	8	1	A.M.		9	16	12	23			59	14	849	
	do 19 H. W.	11	8	A.M.	3			8	50	12	23	57	18	010	3 161
10	do 19 L. W.	7	58	P.M.		3	25					57	14	810	3 200
	do 19 H. W.	11	33	P.M.	3	25		9	12	12	30	56	18	716	3 906
10	do 20 L. W.	8	45	A.M.				9	12	12	30	56	14	822	3 818
	do 20 H. W.	11	33	A.M.	3	2		8	43	12	21	55	17	940	3 042
10	do 20 L. W.	8	36	P.M.				9	6	12	20	41	14	832	3 101
	do 21 L. W.	12	14	A.M.	3	38		9	6	12	20	41	14	746	3 907
11	do 21 L. W.	9	20	A.M.								46	17	736	2 722
	do 21 H. W.	12	34	P.M.	3	14		8	36	12	18	53	15	008	2 722
11	do 21 L. W.	9	10	P.M.								46	17	736	2 722
	do 22 H. W.	12	32	A.M.	3	42		9	46	12	40	52	18	647	3 633
12	do 22 L. W.	10	38	A.M.				9	3	12	44	51	14	852	1 950
	do 22 H. W.	1	32	P.M.	2	54		9	3	12	44	51	14	852	1 950
12	do 22 L. W.	10	35	P.M.				9	3	12	44	51	14	852	1 950
	do 23 H. W.	2	16	A.M.	3	41		9	34	13	15	62	18	873	2 187
13	do 23 L. W.	11	30	A.M.				7	47	11	35	31	13	672	1 546
	do 23 H. W.	3	31	P.M.	3	41		9	34	13	15	62	18	873	2 187
13	do 24 L. W.	11	18	P.M.				9	34	13	15	62	18	873	2 187
	do 24 H. W.	3	6	A.M.	3	48		9	34	13	15	62	18	873	2 187
14	do 24 L. W.	11	45	A.M.				9	34	13	15	62	18	873	2 187
	do 24 H. W.	4	0	P.M.	4	15		9	0	12	25	73	15	347	1 616
14	do 25 L. W.	1	0	A.M.				9	0	12	25	73	15	347	1 616
	do 25 H. W.	4	25	A.M.	3	25		9	45	13	33	72	18	856	1 289
15	do 25 L. W.	2	10	P.M.				9	45	13	33	72	18	856	1 289
	do 25 H. W.	5	58	P.M.	3	48		9	45	13	33	72	18	856	1 289
15	do 26 L. W.	1	35	A.M.				7	37	11	58	47	13	010	1 204
Totals	18 H. W.	97	2	12	0							145	593	219	351
	18 L. W.	109	2									31	136	26	836
Means	18 H. W.	112	41	8	0	45	56	124	54	175	11	35	789	301	298
	18 L. W.	148	41									42	46	16	873
Means	do					3	32	8	55	12	31	2	286	2	632
	do											12	55	14	572

N. E. Maximum in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °.  
 a. Fairly wind, hardly perceptible, fine. b. Fine, clear weather.  
 c. N. W. wind, just perceptible, fine and bright. d. N. W. wind: clear, cold weather.  
 e. Ordinary N. E. breeze; cold and clear. f. East N. E. breeze, fine day.  
 g. Fresh N. E. breeze; fine day. h. N. E. breeze; fair day. i. Fresh N. E. breeze: rain.  
 j. N. E. wind; cold rain. k. Cloudy N. W. breeze; fair weather.  
 l. Still N. W. breeze; sky clear. m. Maximum = 30 f.  
 n. Maximum diurnal inequality = 2.34 feet. N. W. wind: fair; cold.

## APPENDIX 13.

TABLE VII.—Tidal Fluctuations at Batiscan during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."									
Diurnal Inequalities.					Lunital intervals.		Oscillations of float in hundredths of a foot.	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on first times: (No. 2).	Length of half tide day H. W. to H. W.		Priming—or lagging + of tides	Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.	Series II. Losing tides. Gauge book reference numbers.	
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.				Upper passage.	Lower passage.	Ages, etc.		H.	M.		H.	M.			Min
Min	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min	H.	M.			
		149												— 7					
2	697	039	013	136	9	18						12 21			9 27	116		9	
5	706	088	005	039	9	14	2	19	2 8			12 22			9 20	113		10	
1	776	069	002	025	9	5			2 48			12 1			9 13	108			
1	806	159	004	093	8	48	3	16	3 8			12 21			9 6	101			
2	1 010	010	004	161	8	49			3 45			12 22			8 59	94		11	
22	911	150	152	463	8	39	4	13	4 8			12 23			8 53	86			
4	2 345	806	665	* 674	8	51			4 41			12 24			8 48	77		12	
31	230	467	* 776	278	9	9	5	7	5 8			12 25			8 47	68			
100	854	213	235	207	9	57			5 34	1		12 27		+	8 47	60		13	
79	1 411	* 968	327	098	9	6	6	0	6 8			12 30		+	8 51	52			
29	855	909	076	211	9	35	* 25		6 25			12 34			9 0	46		14	
68	427	909	675	069	9	36	5		7 8			12 40							
95	1 133	348	389	058	10	45			7 13			12 44		+	9 16	41		15	
	1 024	038	197						8 8			12 47							
439	13 185	4 738	3 361	2 709	121	2		27	44	32	16	82 3 + 96 0 = 178 3	174	40	+ 50 — 18 + 17 — 6	118	3	1001	
34	0 942	0 338	0 240	0 194	9	19		4	37	4	37	13	42	12	29	9	5	77 00	

- n. Strong N.W. wind; cloudy and cold. o. N.W. breeze; cold.  
 p. Gentle N.W. breeze; freezing hard; fine. q. S.W. wind; fair.  
 r. Moon's first quarter (Quebec) Oct. 23rd, from 0h. 40m. p.m.; cloudy.  
 s. Stiff N.E. breeze; snowing hard. t. N.E. breeze; raining. u. High S.W. wind or gale; rain.  
 v. S.W. wind, going down. w. Moderate S.W. breeze; clear and frosty.  
 x. N.W. breeze; foggy at intervals. y. Light N.W. breeze; bright and cold.  
 z. Gentle N.W. breeze; clear and cold.

## APPENDIX 13.

TABLE VII.—Tidal Fluctuations at Batiscan during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																														
Gauge book reference numbers. Series III. Losing tides.	High and low waters observed each civil day.	Time, Eastern Standard.			Duration of floods.		Duration of ebbs.		Length of half tide day H.W. to H.W.		Priming—or lagging + of tides.	Duration of apparent stand within 0.46 feet.	Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	In duration of floods.		In duration of ebbs.										
		H.	M.	A.M. or P.M.	H.	M.	H.	M.	Min.	Min.								Feet.	Feet.	Feet.	Feet.	Min	Min							
16	Oct. 26 L.W.	4	35	A.M.							+ 68		13	010																
	do 26 H.W. a	5	56	A.M.	4	21					+ 6	69	15	238	2	228			14	007	1	766			17		77			
	do 26 L.W. b	2	50	P.M.			8	54	12	58			82	13	238		2	000												
	do 26 H.W. c	6	54	P.M.	4	4							73	14	869	1	631			14	166	1	964					48		
17	do 27 L.W. d	3	0	A.M.			8	6	11	58			60	13	130		1	739							12					
	do 27 H.W. e	6	52	A.M.	3	52					- 24	43	15	615	2	485			14	377	2	157			15					
	do 27 L.W. f	3	43	P.M.			8	51	12	28			90	13	467		2	148												
	do 27 H.W. g	7	20	P.M.	3	37							47	15	724	2	257			14	630	2	245			3				
18	do 28 L.W. h	4	6	A.M.			8	46	12	20			71	13	547		2	177												
	do 28 H.W. i	7	40	A.M.	3	34					+ 10	38	15	943	2	396			14	715	2	277					17			
	do 28 L.W. j	4	43	P.M.			9	3	12	40			85	13	607		2	336							3					
	do 28 H.W. k	8	20	P.M.	3	37							55	15	804	2	197			14	759	2	304			5				
19	do 29 L.W. l	4	51	A.M.			8	31	12	3			63	13	607		2	197												
	do 29 H.W. m	8	23	A.M.	3	32					- 19	48	16	092	2	485			14	888	2	692					24			
	do 29 L.W. n	5	18	P.M.			8	55	12	28			32	13	477		2	615							1					
	do 29 H.W. o	8	51	P.M.	3	33							26	16	946	3	469			15	211	2	988			0				
20	do 30 L.W. p	5	27	A.M.			8	36	12	9			54	13	955		2	991												
	do 30 H.W. q	9	0	A.M.	3	33					- 38	35	16	833	2	878			15	477	2	795					2			
	do 30 L.W. r	5	38	P.M.			8	38	12	3			62	14	204		2	629							8					
	do 30 H.W. s	9	3	P.M.	3	25							37	16	887	2	683			15	441	2	414					29		
21	do 31 L.W. t	6	10	A.M.			9	7	12	23			72	14	263		2	624												
	do 31 H.W. u	9	26	A.M.	3	16					- 13	50	15	982	1	719			15	120	2	152					7			
	do 31 L.W. v	6	26	P.M.			9	0	12	14			70	13	825		2	157							2					
	do 31 H.W. w	9	40	P.M.	3	14							60	15	933	2	108			14	796	2	298					2		
22	Nov. 1 L.W. x	6	38	A.M.			8	58	12	23			52	13	468		2	465												
	do 1 H.W. y	10	3	A.M.	3	25					- 17	41	15	932	2	464			14	782	2	530						1		
	do 1 L.W. z	7	0	P.M.			8	57	12	10			67	13	567		2	365												
	do 1 H.W. aa	10	13	P.M.	3	13							33	16	390	2	823			14	806	2	467					11		
23	do 2 L.W. ab	7	21	A.M.			9	8	12	40			64	13	577		2	813												
	do 2 H.W. ac	10	53	A.M.	3	32					- 15	70	15	445	1	868			11	714	2	473						45		
	do 2 L.W. ad	7	16	P.M.			8	23	11	55			40	13	378		2	067												
	do 2 H.W. ae	10	48	P.M.	3	32							30	16	524	3	146			14	794	2	703					36		
Totals 15½ tides.		H.W.	139	22							- 16	755	256	157																
		L.W.	80	27			57	20	131	53	184	52	- 126	964	204	310			38	837	35	323	236	683	38	225	117		400	
Means		16 H.W.					3	35	8	48	12	19	+ 8	47	16	010			2	427	2	355	14	793	2	389	8		25	
		15 L.W.										- 21	64	13	621															

N.B.—Maxima in lunar month indicated by a star, thus: \* and minima by a circle, thus: °

a N.W. wind, just perceptible. Fine, clear, frosty weather.

b S.W. wind do do do

c do do do

d Stiff N.E. breeze. Clear and cold.

e do do Hard frost.

f N.E. wind just perceptible. Fine, clear, but milder weather.

g N.E. wind. Fine.

h N.E. wind. Fine and bright.

i N.E. wind, hardly perceptible.

j S.W. wind, just perceptible. Fine and mild.

k do do Cloudy, mild.

l Feeble S.W. wind. Sky overcast, appearance of rain.

m Feeble N. wind. Commencing to rain.

n Northerly breeze. Cold. Snow flurries. Moon crosses equator, Oct. 29th.

## APPENDIX 13.

TABLE VII.—Tidal Fluctuations at Batiscan during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 2th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).					RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."													
Diurnal Inequalities.					Lunital intervals. Oscillations of float in hundredths of a foot.		Eastern standard civil times of meri- dian passages im- mediately preced- ing observed high waters, with corre- sponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on times: (No. 2.)		Length of half tide day H. W. to H. W.		Priming + or lagging—of tides.		Lunital intervals.		General coefficients of semi-ampli- tudes from "l'Annuaire des Ma- rees," corresponding to observed tides assumed to be 48 hours old.
In semi duration.	In high water levels	In low water levels	In mean tide levels	In amplitudes.			Upper passage.	Lower passage.	Ages, etc.									
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.		
40		228			10	20	7	36		5	36			+ 34				
39	369		159	198	10	56			9 8	6	17			+ 38	10	0	40	
38	746		211	193	10	32				6	54			12 37	10	19	42	16
37	109	337	253	088	10	32			10 8	6	54			+ 18	10	34	46	
36		080		085	10	38			8 42	7	25				10	43	51	17
35	219		085	032	10	37				7	52			+ 0	10	49	56	
34	139	060	044	027	10	37			11 8	8	15							
33		000			10	56			9 24	8	15				10	51	61	18
32	288		129	388	10	38			9 45	8	36			— 10	10	49	65	
31	854		323	296	10	38			12 8	8	55				10	45	70	19
30	113	478	266	193	10	45			10 6	9	12				10	41	74	
29		249		036	10	33			10 27	9	29			— 16	10	36	77	20
28	054	009	036	381	10	15			10 48	9	45				10	30	80	
27	906		321	262	10	17			11 9	10	0				10	24	83	21
26	049	438	324	146	10	10			11 30	10	16			— 20	10	16	85	
25		357		014	10	11			11 52	10	30				10	08	86	22
24	001	099	024	063	9	59			12 14	10	45				10	0	88	
23	458	010	092	006	10	16			12 37	11	0						86	23
22	945	199	080	230	10	16			16 8	11	0							
21	1 079				9	40			1									
20																		
19																		
18																		
17																		
16																		
15																		
14																		
13																		
12																		
11																		
10																		
9																		
8																		
7																		
6																		
5																		
4																		
3																		
2																		
1																		
0																		
417	6 328	2 832	2 361	2 735	166	51			71 42 + 12 0 = 83 42	140	47	185	24	+ 56 — 85 + 19 — 17	168	16	1082	
20	422	189	157	182	10	26			10 6	10	28				10	31	68 00	

\* Northerly breeze. Cold. Snowing. Moon in *w* N. breeze, just perceptible. Bright and cold.  
 † S.W. breeze. Sky clearing up.  
 ‡ Gentle N. breeze. Sky clearing up.  
 § do do Fine clear, cold.  
 ¶ S.W. breeze.  
 †† S.W. breeze.  
 ‡‡ Ordinary S.W. breeze.  
 §§ Moderate S.W. breeze. Cloudy, but mild.  
 ¶¶ Full moon (Quebec) Oct. 31st, at 4h. 31m. p.m. mild.  
 ††† S. breeze clear and cold.

## APPENDIX 13.

TABLE VII.—Tidal Fluctuations at Batiscan during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																								
Gauge book reference numbers. Series III. Lowing tides.		High and low waters observed each civil day.	Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide day H.W. to H.W.		Priming—or lagging + of tides.	Duration of apparent stand within 0.05 feet.	Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.		Ranges of ebbs.		Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	Induration of floods.		Induration of ebbs.		
			H.	M.	A.M. or P.M.	H.	M.	H.	M.	H.				M.	Min.	Min.	Feet.			Feet.	Feet.	Feet.	Feet.	Feet.
16	4	Oct. 26	L.W.	4	35	A.M.						+ 68		13 010										
		do	26 H.W.	a	5 56	A.M.	4	21				+ 6	69	15 238	2 228			14 007	1 766			17	7	
		do	26 L.W.	b	2 50	P.M.			8	54	12	58		82	13 238		2 000		14 166	1 964				48
		do	26 H.W.	c	6 54	P.M.	4	4						73	14 869	1 631		1 730			12			
		do	27 L.W.	d	3 0	A.M.			8	6	11	58		60	13 130				14 377	2 157				45
17		do	27 H.W.	e	6 52	A.M.	3	52				24	43	15 615	2 485			14 630	2 245			15	5	
		do	27 L.W.	f	3 43	P.M.			8	51	12	28		90	13 467		2 148							
		do	27 H.W.	g	7 20	P.M.	3	37						47	15 724	2 257		2 177			3			
		do	28 L.W.	h	4 6	A.M.			8	46	12	20		71	13 547				14 715	2 277				17
		do	28 H.W.	i	7 40	A.M.	3	34					+ 10	38	15 943	2 396		2 336						
18		do	28 L.W.	j	4 43	P.M.			9	3	12	40		85	13 607				14 759	2 304				32
		do	28 H.W.	k	8 20	P.M.	3	37						55	15 804	2 197		2 197						
		do	29 L.W.	l	4 51	A.M.			8	31	12	3		63	13 607				14 888	2 692				24
		do	29 H.W.	m	8 23	P.M.	3	32					19	48	16 092	2 485		2 615						
		do	29 L.W.	n	5 18	P.M.			8	55	12	28		32	13 477				15 211	2 988				19
19		do	29 H.W.	o	8 51	P.M.	3	33						26	16 946	3 469								
		do	30 L.W.	p	5 27	A.M.			8	36	12	9		54	13 955		2 991		15 477	2 795				2
		do	30 H.W.	q	9 0	A.M.	3	33					* 38	35	16 833	2 878		2 629						
		do	30 L.W.	r	5 38	P.M.			8	38	12	3		62	14 204				15 441	2 414				29
		do	30 H.W.	s	9 3	P.M.	3	25						37	16 887	2 683		2 624						
20		do	31 L.W.	t	6 10	A.M.			9	7	12	23		72	14 263				15 120	2 152				7
		do	31 H.W.	u	9 26	A.M.	3	16					13	50	15 982	1 719		2 157						
		do	31 L.W.	v	6 26	P.M.			9	0	12	14		70	13 825				14 796	2 298				2
		do	31 H.W.	w	9 40	P.M.	3	14						60	15 933	2 108		2 465						
		Nov. 1	L.W.	x	6 38	A.M.			8	58	12	23		52	13 468				14 782	2 530				1
22		do	1 H.W.	y	10 3	A.M.	3	25					17	41	15 932	2 464		2 365						
		do	1 L.W.	z	7 0	P.M.			8	57	12	10		67	13 567				14 806	2 467				11
		do	1 H.W.	aa	10 13	P.M.	3	13						33	16 390	2 823		2 813						
		do	2 L.W.	bb	7 21	A.M.			9	8	12	40		64	13 577				11 714	2 473				45
		do	2 H.W.	cc	10 53	A.M.	3	32					15	70	15 445	1 868		2 067						
23		do	2 L.W.	bb	7 16	P.M.			8	23	11	55		40	13 378				14 794	2 703				0
		do	2 H.W.	cc	10 48	P.M.	3	32						30	16 524	3 146								
Totals 15½ tides.			H.W.	139 22				57 20	131	53 184	52	+ 16	755	256 157	38 837	35 323	236 683	38 225	117	400				
			L.W.	80 27								- 126	964	204 310										
Means			16 H.W.					3 35	8 48	12 19		+ 8	47	16 010	2 427	2 355	14 793	2 389	8	25				
			15 L.W.									- 21	64	13 621										

N.B.—Maxima in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °

a N.W. wind, just perceptible. Fine, clear, frosty weather.  
 b S.W. wind do do do  
 c do do do do  
 d Stiff N.E. breeze. Clear and cold.  
 e do do Hard frost.  
 f N.E. wind just perceptible. Fine, clear, but milder weather.  
 g N.E. wind. Fine.  
 h N.E. wind. Fine and bright.  
 i N.E. wind, hardly perceptible.  
 j S.W. wind, just perceptible. Fine and mild.  
 k do do do Cloudy, mild.  
 l Feeble S.W. wind. Sky overcast, appearance of rain.  
 m Feeble N. wind. Commencing to rain.  
 n Northerly breeze. Cold. Snow flurries. Moon crosses equator, Oct. 29th.

## APPENDIX 13.

TABLE VII.—Tidal Fluctuations at Batiscan during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 2th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."													
Diurnal Inequalities.					Lunital intervals.		Oscillations of float in hundredths of a foot.		Eastern standard civil times of meri- dian passages im- mediately preced- ing observed high waters, with corres- ponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)		Length of half tide day H. W. to H. W.		Priming + or lagging—of tides.		Lunital intervals.		General coefficients of semi-ampli- tudes from "l'Annuaire des Ma- rees," corresponding to observed tides assumed to be 48 hours old.		Series III. Losing tides. Gauge book reference numbers.	
In mean direction.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.					Upper passage.	Lower passage.	Ages, etc.												
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.		H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.		H.	M.			
60		228			10	20		7	36				5	36	+ 34								
60	369		159	198	10	56							6	17	+ 38	10	0				40		
30	746		211	193	10	32							6	54	+ 18	10	34				46	16	
8	109		253	088	10	38							7	25			10	43			51	17	
20	219		085	032	10	37							7	52	+ 0	10	49				56		
37	139		044	027	10	56							8	15			10	51			61	18	
25	288		129	388	10	38							8	36	- 10	10	49				65		
19	854		323	296	10	45							8	55			10	45			70	19	
6	113		266	193	10	33							9	12	- 16	10	41				74		
20	054		036	381	10	15	7						9	29			10	36			77	20	
9	905		321	262	10	17							9	45	- 19	10	30				80		
9	049		324	146	10	10	1						11 30	10 0			10	24			83	21	
13	009		014	232	10	11							10 16		- 20	10	16				85		
30	438		024	063	9	59							12 14	10 30			10	8			86	22	
45	945		092	006	10	16	2						10 45		- 20	10	0				89		
25	1 079		080	230	9	40	3						16 8	11 0							86	23	
417	6 328	2 832	2 361	2 735	166	51					71 42	+ 12 0		140	47	185	24	+ 56	168	16	1082		
25	422	189	157	182	10	26					10 6	10 28		8 48	12 22			- 85					
																		+ 19					
																		- 17					

\* Northerly breeze. Cold. Snowing. Moon in w N. breeze just perceptible. Bright and cold.  
 † Gentle N. breeze. Sky clearing up. x S.W. wind, clear hard frost.  
 ‡ do do Fine clear, cold. y do diminishing. Fine.  
 § S.W. breeze. z do getting stronger.  
 || S.W. breeze. aa High S.W. wind. Clouding up.  
 ¶ Moderate S.W. breeze. Cloudy, but mild. bb S.W. wind, hardly perceptible. Sky overcast, mild.  
 †† Full moon (Quebec) Oct. 31st, at 4h. 31m. p.m. mild.  
 ‡‡ S. breeze clear and cold.



## APPENDIX 13.

TABLE VII.—Tidal Fluctuations at Batiscan during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.— (Continued.)								REMARKS.
Mean amplitudes corrected for diurnal inequalities.	Diurnal Inequalities.							
	In duration of floods.	In duration of ebbs.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.	
Feet.	Min	Min	Min	Feet.	Feet.	Feet.	Feet.	
					129			
2 922	10			432		224	219	Light N. breeze ; cloudy..
		37	14		100			Feeble northerly breeze
	23			1 114		253	108	Sky overcast ; light N.E. wind ; appearance of rain or snow.
3 030		42	22		298			Stiff N.E. breeze ; appearance of rain or snow..... 24
	20			567		192	073	Commencing to rain at 8.45 a.m.
2 937		37	29		159			
	8			646		091	241	Moderate N.W. breeze ; clear, cold weather.....
2 716		52	47		100			do do fine, freezing hard..... 25
	5			1 576		342	275	Fresh N.W. breeze ; fine, bright and cold.....
2 441		59	59		308			do do clear, cold weather.....
	0			591		324	201	+N.W. breeze gone down considerably..
2 240		72	77		139			Feeble N.W. breeze ; snowing..... 26
	5			1 302		124	097	do do do.....
2 337		106	78		209			do do do.....
	28			1 706		124	118	
2 455		104	61		339			N.E. wind, hardly perceptible ; fine, moderate N.E. 27
	43			1 377		102	033	wind.
2 422		88	53		100			N. wind do do fine and mild.....
	35			1 391		063	091	do do do.....
2 331		96	80		060			Ordinary S.W. breeze.....
	16			1 849		309	281	Stiff S.W. breeze ; mild..... 28
2 056		101	40		397			Stiff N.W. breeze ; clear and cold.....
	61			511		235	133	Moderate N.W. breeze.....
1 917		48	0		060			do do do.....
	48			380		035	169	Gentle S.W. wind ; clear and bright..... 29
1 748		15	15		180			Gentle S.W. wind ; clear weather.....
	10			050		152	045	Calm, clear and bright.....
1 703		10	20		170			Moderate N.E. breeze ; cloudy, snowing..... 30
	0			803				
33 209	312	867	595	14 295	2 748	2 572	2 084	
2 376	21	62	43	953	183	184	149	
141 330	986	2363	1841	41 942	12 428	10 449	9 809	
2 882	17	41	32	723	214	187	175	

+Moon's N. declination a maximum=20° 39'. †Moon's last quarter (Quebec) from 0h. 02m., p.m., Nov. 8th. §Maximum inequality observed in low water levels=1'100 feet.



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## APPENDIX 13.

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TIDAL FLUCTUATIONS, ETC.,

AT

CHAMPLAIN,

DURING THE LUNAR MONTH OF THE LOW WATER SEASON OF 1887,  
OCTOBER 9 TO NOVEMBER 8.

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### TABLE VIII.

WEEKLY SERIES OF GAINING TIDES Nos. I. and III.  
" " LOSING " No. IV.

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## APPENDIX 13.

TABLE VIII.—Tidal Fluctuations at Champlain during the Low water season of 1887,  
viz.:—from quadrature, October 9th, to quadrature, November 8th.

## DIRECT RESULTS OF TIDAL OBSERVATIONS, &amp;c.

Groups each representing numbers. Series of running tide.	High and low waters, at each civil day.	Time, Eastern Standard.	Duration of floods.		Duration of ebb.		Length of half tide day H. W. to H. W.		Timing or lagging of tides Duration of apparent stand within 0.05 feet.		Elevations of summits and troughs of fluvial tide waves		Ranges of floods.		Ranges of ebb.		Mean tide levels corrected for diurnal inequalities.		Mean amplitudes corrected for diurnal inequalities.		In duration of floods.		In duration of ebb.	
			h	m	h	m	h	m	M <sub>1</sub>	M <sub>2</sub>	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Min	Min	Min	Min
100	10	10	10	10	10	10	10	10			10	10	10	10	10	10	10	10	10	10	10	10	10	10
101	11	11	11	11	11	11	11	11			11	11	11	11	11	11	11	11	11	11	11	11	11	11
102	12	12	12	12	12	12	12	12			12	12	12	12	12	12	12	12	12	12	12	12	12	12
103	13	13	13	13	13	13	13	13			13	13	13	13	13	13	13	13	13	13	13	13	13	13
104	14	14	14	14	14	14	14	14			14	14	14	14	14	14	14	14	14	14	14	14	14	14
105	15	15	15	15	15	15	15	15			15	15	15	15	15	15	15	15	15	15	15	15	15	15
106	16	16	16	16	16	16	16	16			16	16	16	16	16	16	16	16	16	16	16	16	16	16
107	17	17	17	17	17	17	17	17			17	17	17	17	17	17	17	17	17	17	17	17	17	17
108	18	18	18	18	18	18	18	18			18	18	18	18	18	18	18	18	18	18	18	18	18	18
109	19	19	19	19	19	19	19	19			19	19	19	19	19	19	19	19	19	19	19	19	19	19
110	20	20	20	20	20	20	20	20			20	20	20	20	20	20	20	20	20	20	20	20	20	20
111	21	21	21	21	21	21	21	21			21	21	21	21	21	21	21	21	21	21	21	21	21	21
112	22	22	22	22	22	22	22	22			22	22	22	22	22	22	22	22	22	22	22	22	22	22
113	23	23	23	23	23	23	23	23			23	23	23	23	23	23	23	23	23	23	23	23	23	23
114	24	24	24	24	24	24	24	24			24	24	24	24	24	24	24	24	24	24	24	24	24	24
115	25	25	25	25	25	25	25	25			25	25	25	25	25	25	25	25	25	25	25	25	25	25
116	26	26	26	26	26	26	26	26			26	26	26	26	26	26	26	26	26	26	26	26	26	26
117	27	27	27	27	27	27	27	27			27	27	27	27	27	27	27	27	27	27	27	27	27	27
118	28	28	28	28	28	28	28	28			28	28	28	28	28	28	28	28	28	28	28	28	28	28
119	29	29	29	29	29	29	29	29			29	29	29	29	29	29	29	29	29	29	29	29	29	29
120	30	30	30	30	30	30	30	30			30	30	30	30	30	30	30	30	30	30	30	30	30	30
121	31	31	31	31	31	31	31	31			31	31	31	31	31	31	31	31	31	31	31	31	31	31
122	32	32	32	32	32	32	32	32			32	32	32	32	32	32	32	32	32	32	32	32	32	32
123	33	33	33	33	33	33	33	33			33	33	33	33	33	33	33	33	33	33	33	33	33	33
124	34	34	34	34	34	34	34	34			34	34	34	34	34	34	34	34	34	34	34	34	34	34
125	35	35	35	35	35	35	35	35			35	35	35	35	35	35	35	35	35	35	35	35	35	35
126	36	36	36	36	36	36	36	36			36	36	36	36	36	36	36	36	36	36	36	36	36	36
127	37	37	37	37	37	37	37	37			37	37	37	37	37	37	37	37	37	37	37	37	37	37
128	38	38	38	38	38	38	38	38			38	38	38	38	38	38	38	38	38	38	38	38	38	38
129	39	39	39	39	39	39	39	39			39	39	39	39	39	39	39	39	39	39	39	39	39	39
130	40	40	40	40	40	40	40	40			40	40	40	40	40	40	40	40	40	40	40	40	40	40
131	41	41	41	41	41	41	41	41			41	41	41	41	41	41	41	41	41	41	41	41	41	41
132	42	42	42	42	42	42	42	42			42	42	42	42	42	42	42	42	42	42	42	42	42	42
133	43	43	43	43	43	43	43	43			43	43	43	43	43	43	43	43	43	43	43	43	43	43
134	44	44	44	44	44	44	44	44			44	44	44	44	44	44	44	44	44	44	44	44	44	44
135	45	45	45	45	45	45	45	45			45	45	45	45	45	45	45	45	45	45	45	45	45	45
136	46	46	46	46	46	46	46	46			46	46	46	46	46	46	46	46	46	46	46	46	46	46
137	47	47	47	47	47	47	47	47			47	47	47	47	47	47	47	47	47	47	47	47	47	47
138	48	48	48	48	48	48	48	48			48	48	48	48	48	48	48	48	48	48	48	48	48	48
139	49	49	49	49	49	49	49	49			49	49	49	49	49	49	49	49	49	49	49	49	49	49
140	50	50	50	50	50	50	50	50			50	50	50	50	50	50	50	50	50	50	50	50	50	50
141	51	51	51	51	51	51	51	51			51	51	51	51	51	51	51	51	51	51	51	51	51	51
142	52	52	52	52	52	52	52	52			52	52	52	52	52	52	52	52	52	52	52	52	52	52
143	53	53	53	53	53	53	53	53			53	53	53	53	53	53	53	53	53	53	53	53	53	53
144	54	54	54	54	54	54	54	54			54	54	54	54	54	54	54	54	54	54	54	54	54	54
145	55	55	55	55	55	55	55	55			55	55	55	55	55	55	55	55	55	55	55	55	55	55
146	56	56	56	56	56	56	56	56			56	56	56	56	56	56	56	56	56	56	56	56	56	56
147	57	57	57	57	57	57	57	57			57	57	57	57	57	57	57	57	57	57	57	57	57	57
148	58	58	58	58	58	58	58	58			58	58	58	58	58	58	58	58	58	58	58	58	58	58
149	59	59	59	59	59	59	59	59			59	59	59	59	59	59	59	59	59	59	59	59	59	59
150	60	60	60	60	60	60	60	60			60	60	60	60	60	60	60	60	60	60	60	60	60	60

1000 ft.

Time is a circle, thus:  
 1000 ft. is a low water of Greenwich.

## APPENDIX 13.

TABLE VIII.—Tidal Fluctuations at Champlain during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued.)							RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."											Series I. Gauging tides. Gauge book reference numbers.					
Diurnal Inequalities.					Lunital intervals.		Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.					Eastern standard civil times of high water at Quebec, based on Best times: (No. 2.)				Length of half tide day H.W. to H.W.		Priming—or lagging + of tides		Lunital intervals.		General coefficients of semi-amplitudes from "L'Annuaire des Mares," corresponding to observed tides assumed to be 48 hours old.	
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.																			
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	Upper passage.	Lower passage.	Ages, etc.	Days.	H.	M.	H.	M.	H.	M.	H.	M.	Min.	H.	M.		
		100																	+ 34				1
10	1 002	553			10	10		7 20				5 21			12 46					10	1		39
40	1 102	053	125	250	10	32	7 48		25 1			6 7			12 43			+ 40	10	19		42	
50	1 200		362	477	10	15		8 15				6 50			12 39					10	35		47
20	800		244	112	10	47	8 43		26 1			7 29			12 39			+ 22	10	46		54	
60	1 150		118	662	10	10		9 10				8 2			12 33				10	52		62	
20	650		144	238	10	32	9 38		27 1			8 31			12 29			+ 5	10	53		71	
30	1 200		318	113	10	35		10 5				8 57			12 26				10	52		80	
60	700		050	250	10	7	10 33		28 1			9 22			12 25			— 2	10	49		89	
10	100		112	275	10	39		11 1				9 45			12 23				10	44		97	
15	1 000		112	675	10	27	11 28		29 1			10 7			12 22			— 6	10	39		104	
5	100		213	425	10	24		11 56				10 29			12 22				10	33		110	
20	900		375	100	10	16	12 24		0 8			10 51			12 22			— 7	10	27		114	
20	000		362	075	9	47		12 53				11 12			12 21				10	19		116	
	400		056	113	9	39	1 21		1 8			11 34			12 22			— 7	10	13		* 117	
37	10 304	4 906	2 591	3 765	144	20	61 55	70 40			124	37	175 0			+ 67				148	2	1142	
							+ 12 0									— 22							
							= 73 55																
28	736	351	199	290	10	17	10 33	10 6			8 54	12 30			+ 22					10	34	81 57	
																— 6							

§ Moon crosses equator, October 16th. || Moon in perigee, October 16th, at 1h. 0m. p.m.

\* New moon (Quebec) at 5h. 35m. p.m. October 16th. † Most important tide but one during 1887.

‡ Evening tide of March 11th, for which coefficient of semi-amplitude is 118.



## APPENDIX 13.

TABLE VIII.—Tidal Fluctuations at Champlain during the Low water season of 1887, viz.:—from quadrature of October 9th to quadrature of November 8th.

**DIRECT RESULTS OF TIDAL OBSERVATIONS—**  
(Continued).

**RESULTS BASED ON DATA FROM  
NAUTICAL ALMANAC  
AND "L'ANNUAIRE DES MARÉES."**

Diurnal Inequalities.								Lunital intervals.		Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times; (No. 2.)			Length of half tide day H. W. to H. W.		Priming—or lagging + of tides		Lunital intervals.		General coefficients of semi-amplitudes from "L'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.	Series III. Gaining tides. Gauge book reference numbers.
In duration of floods.	In duration of ebbs.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.																	
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	Oscillations of float in hundredths of a foot.	Upper passage	Lower passage	Ages, etc.	H.	M.	H.	M.	H.	M.	Min	H.	M.		
				600			11	3		7	37		6	14		+38	10	37		40			
			125	300			11	41			7	59		6	55		10	56		42			16
	50	54	275		097	032	11	25		8	21			7	32	+18	11	11		46			
	24	28		075	209	470	11	37			8	43		8	3		11	20		51			17
	4	14	1 000	025	172	418	11	36			9	4		8	30	+0	11	26		56			
	10	60	050	100	087	149	11	35			9	25		8	53		11	28		61			18
	50	10	425	125	087	149	11	35			9	25		8	53		11	28		61			18
	50	10	250	032	062	113	11	34		9	46			9	14	—10	11	28		65			
	15	5	075	178	081	113	11	38			10	7		9	33		11	26		70			19
	5		075	275	437	151	11	2		10	28			9	50	—16	11	22		74			
	25	80	025	450	215	106	11	46			10	49		10	7		11	18		77			20
	35	75	125	214	182	115	11	15		11	10			10	23	—19	11	13		80			
	45		050	125	257	812	11	9			11	31		10	38		11	7		83			21
	75	145	425	237	612	1057	11	53			12	15		11	8		10	53		86			22
	80		000	125	031	612	10	42		12	38			11	23	—20	10	45		86			
	10	40	000	144	562	1115	10	29			1	1		11	38		10	37		86			23
	10	60	090	975	193	513																	
	40	40	850	075	113	100																	
	0	15																					

448	418	741	6 000	3 800	4 148	4 250	179	44	...	80	57	71 50 =83 50	+12	150	55	185	24	+56 —85 +19	178	8	1088		
32	28	49	400	253	296	304	11	14	....	10	7	1		9	26	12	22		11	8	68	00	
																		—17					



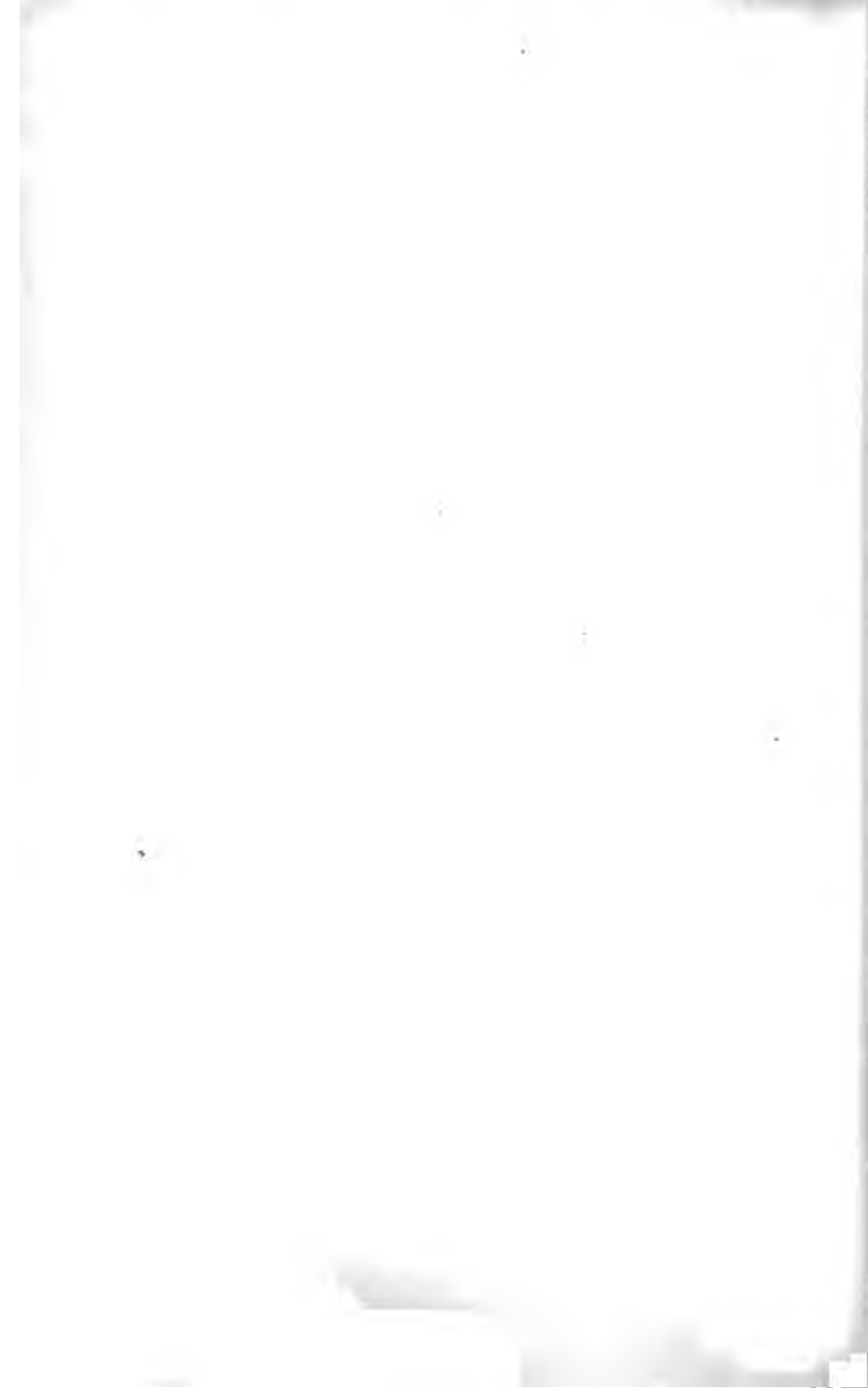
## APPENDIX 13.

TABLE VIII.—Tidal Fluctuations at Champlain during the Low water season of 1887, viz.:—from quadrature, October 9th, to quadrature, November 8th.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).						RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."										Series IV. Losing tides. Gauge book reference numbers.		
Diurnal Inequalities.					Lunital intervals.  Oscillations of float in hundredths of a foot.		Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)		Length of half tide day H. W. to H. W.		Priming—or lagging + of tides			Lunital intervals.  General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.	
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.			Upper passage.	Lower passage.	Ages, etc.	Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)		Length of half tide day H. W. to H. W.		Priming—or lagging + of tides			Lunital intervals.	
										H.	M.	H.	M.	Days.	H.		M.	H.
Min	Feet.	Feet.	Feet.	Feet.	H.	M.												
		200												20				
	500		000	124								12 15			10 29		86	
29	100	075	231	088	10 1		1 24			17 8		11 53		19		10 21		84
30	300				10 12			1 48				12 9				10 12		82
30	400	125	169	087	9 53		2 12					12 24		19		10 3		80
10	400	100	087	200	10 3			2 37				12 40						
	350		176	198								12 16				9 53		76
35	000	055	248	100	10 2		3 3					12 56		16		9 46		73
85	850	345	113	197	10 37			3 28				1 14				9 37		69
25	075				9 46		3 54					1 31		13				
60	*1 650	190	181		9 19				20 8			12 20			9 30		64	
	1 325	275	071	006				4 21				1 51			9 25		59	
50	125		053	056	9 53		4 47					2 12		5				
	1 275	075							5 13			21 8			9 23		55	
60			258	237	9 37							2 36						
	1 550											12 27			9 23		50	
70	350		227	008	10 20		5 40					3 3		9		9 20		47
	325								22 8			12 32						
65	100	006	088		9 54		6 6					3 35			9 38		44	
	028	175			10 32		6 33					4 11		28		9 54		44
	472	037	374		11 11			6 59		23 8		12 42						
65	125	200	176						24 8			12 43						
	075																	
605	9 300	2 500	2 066	2 120	141 20		27 33	30 32				87 8	185 58	+ 37	137 3		913	
												+ 108 0						
												195 8		72				
43	0 620	0 167	0 138	0 141	10 6		3 56	4 22				13 56	12 24	+ 19	9 47	65 21		
														14				
1716	25 604	11 206	8 805	10 135	465 24		182 25	185 2				470 40	546 22	+ 160	463 13	3143		
														179				
														20				
41	0 582	0 255	0 210	0 241	10 35		8 18	8 25				10 42	12 25	+ 13	10 32	71 43		
40	0 649	0 316	0 233	0 254	10 26		7 30	7 29				11 33	12 36	+ 19	10 22	72 70		
														12				

: Maximum diurnal inequality observed in high water levels = 1 650 feet.

§ Moon's last quarter (Quebec), from 0h. 2m. p.m., November 8th.



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## APPENDIX 13.

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TIDAL FLUCTUATIONS, ETC.,

LEVIS GRAVING DOCK, HARBOUR OF QUEBEC,

DURING A COMPLETE LUNAR MONTH OF THE HIGH WATER SEASON  
OF 1888, VIZ., MAY 2 TO JUNE 1.

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### TABLE IX.

WEEKLY SERIES OF GAINING TIDES, No. V.

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## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of gaining tides No. V.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																		
Gauge book reference numbers. Series V. Gaining tides.	High and low waters observed each civil day.	Time, Eastern Standard.			Duration of floods.		Duration of ebbs.		Length of half tide day H.W. to H.W.		Priming — or lagging + of tides.	Duration of apparent stand within 0.66 ft.	Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	
		H.	M.	A.M. or P.M.	H.	M.	H.	M.	H.	M.								Min.
	May 4 L.W.	9	8	P.M.			7	43	13	1		32	1 570					
	May 5 H.W.	2	25	A.M.	5	17					+ 23	31	12 417	10 847		7 557	11 014	
	do 5 L.W.	9	19	A.M.			6	54	12	11		29	2 530		9 887			
9	do 5 H.W.	2	36	P.M.	5	17						29	13 871	11 341		7 736	11 155	
	do 5 L.W.	10	5	P.M.			7	29	12	47		21	1 905		11 966			
	do 6 H.W.	3	23	A.M.	5	18					+ 19	31	13 339	11 429		7 738	11 501	
	do 6 L.W.	10	33	A.M.			7	10	12	22		20	2 070		11 264			
10	do 6 H.W.	3	45	P.M.	5	12						31	13 417	11 347		7 608	11 711	
	do 6 L.W.	11	7	P.M.			7	22	12	25		18	1 435		11 982			
	do 7 H.W.	4	10	A.M.	5	3					- 9	28	13 686	12 251		7 515	12 386	
	do 7 L.W.	11	36	A.M.			7	28	12	34		22	1 200		12 486			
11	do 7 H.W.	4	44	P.M.	5	8						28	14 066	12 866		7 736	12 772	
	do 7 L.W.	11	56	P.M.			7	15	12	10		17	1 500		12 566			
	do 8 H.W.	4	54	A.M.	4	55					- 19	35	14 671	13 171		7 794	13 018	
	do 8 L.W.	12	26	P.M.			7	35	12	21		18	1 070		13 601			
12	do 8 H.W.	5	15	P.M.	4	46						29	13 896	12 736		7 742	13 174	
	do 9 L.W.	12	39	A.M.			7	24	12	10		17	1 240		12 566			
	do 9 H.W.	5	25	A.M.	4	46					- 15	25	15 036	13 796		7 833	13 460	
	do 9 L.W.	1	9	P.M.			7	44	12	25		20	0 986		14 070			
13	do 9 H.W.	5	50	P.M.	4	41						26	14 376	13 410		7 886	14 336	
	do 10 L.W.	1	18	A.M.			7	29	12	14		16	0 500		13 876			
	do 10 H.W.	6	4	A.M.	4	46					- 16	26	16 270	15 870		8 939	14 439	
	do 10 L.W.	1	40	P.M.			7	36	12	20		19	2 040		14 330			
14	do 10 H.W.	6	24	P.M.	4	44						23	15 880	13 780		9 345	14 019	
	do 11 L.W.	1	41	A.M.			7	17	12	9		17	2 640		13 160			
	do 11 H.W.	6	38	A.M.	4	32					- 19	18	17 430	14 790		9 433	14 016	
	do 11 L.W.	2	26	P.M.			7	13	12	22		16	2 210		15 230			
15	do 11 H.W.	6	55	P.M.	4	29						24	15 166	12 886		9 230	13 980	
	do 12 L.W.	2	22	A.M.			7	27	12	10		20			12 816			
Totals 14 tides		88	23				69	14	104	0	172	40	208 326		180 510	179 780	113 711	140 932
Means		100	23									270	21 386					
							4	57	7	26	12	30	17	14 528				
												19	1 634		12 464	12 842	8 122	12 385

N.B. —Maxima in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °

(Corrected mean tide level) No.  $H_2 = \frac{H_1 + H_2}{2}$  (Corrected amplitude) No.  $A_2 = \frac{A_1 - A_2}{2}$

## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of gaining tides No. V.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).										Wind.		Height of barometric column at sea level and for 0° cent or 32° Fah.	REMARKS.
Diurnal Inequalities.													
In duration of floods.	In duration of ebbs.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.	Lunital intervals.	Oscillations of float in hun- dreds of a foot.	Velocity miles per hour.				
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	H	M			Inches.		
									2.731	N.E.	30.177	Longitude, Graving Dock = 71° 11' 30" = 4h. 44m. 40s. = 0.1978 of a day W. of Greenwich.	
50	50		0.960				6	48	4.250	N.E.	30.138	Cloudy, fair.	
0		1.454		.238	.141			4	5.511	N.E.	30.096	Sky overcast.	
35	36		0.625				6	37	4	6.898	N.E.	30.064	Raining.
1		0.557		.057	.346				.546	N.	30.077	Clearing up.	
19	25		0.165				7	2	6.057	N.W.	30.047	Clouds breaking.	
6		0.083		.130	.210				8.807	N.W.	30.022	Sky becoming clearer.	
12	3		0.635				7	3	4	8.795	N.W.	30.021	Cloudy; commencing to rain.
9		0.220		.093	.685				5.807	N.W.	30.028	Sky overcast.	
4	9		0.235				7	7	2	5.545	N.W.	30.058	Cloudy and cold.
5		0.380		.221	.376			4	16.966	N.W.	30.091	Moon crosses the equator; cloudy and cold.	
11	24		0.300				7	20		11.386	N.W.	30.107	Beautiful bright day.
13		0.005		.058	.246				9.568	N.W.	30.195	Fine clear weather.	
20	11		0.430				7	9		7.000	N.W.	30.251	Fine bright morning.
9		0.865		.052	.156			2	8.886	S.W.	30.020	Clear weather, fine.	
11	11		0.170				7	9		3.386	S.W.	30.084	Beautifully bright and clear.
6		1.230		.091	.286				4.671	S.W.	30.020	Clear weather.	
20	15		0.274				7	0	2	8.000	W.	29.875	
5		0.000		.053	.846			1	7.091	W.	29.861	Clear weather.	
15	11		0.466				7	2		5.490	N.W.	29.864	Moon in apogee, May 9th, at 8 p.m.
5		1.994		.613	.153				6.057	N.W.	29.923	Fine clear weather.	
8	6		1.540				6	55	2	9.545	S.E.	29.982	Maximum diurnal inequality in low water levels observed, 1.540 feet.
2		0.570		.846	.449			10	10.227	N.E.	29.980	Bright morning. Raining heavily.	
19	11		0.600				6	53	4	11.955	N.E.	29.989	New moon (Quebec) May 10, at 8h. 24m. p.m. Clearing up.
8		1.630		.088	.006			2	12.708	N.E.	30.050	Clear weather.	
36	13		0.430				6	40	1	10.977	N.E.	30.098	Cloudy.
23		2.324		.203	.056			25	9.000	N.E.	30.079		
26	12		0.080				6	40	3	10.545	N.E.	30.080	Fine clear day.
14		2.094						2	4.114	N.E.	30.030		
100	280	237	14.695	6.910	2.743	3.956	97	25	219.788		840.130		
7	20	17	1.050	.494	.211	.304	6	58	7.850		30.065		



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## APPENDIX 13.

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TIDAL FLUCTUATIONS, ETC.,

LEVIS GRAVING DOCK, HARBOUR OF QUEBEC.

DURING A COMPLETE LUNAR MONTH OF THE HIGH WATER SEASON  
OF 1888, VIZ., MAY 2 TO JUNE 1.

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### TABLE IX.

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WEEKLY SERIES OF LOSING TIDES, No. VI.

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## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of losing tides No. VI.

Gauge book reference number. Series VI. Losing tides.	DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.												
	High and low waters observed each civil day.	Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide day H. W. to H. W.		Priming—or lagging + of tides.		Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.
		H. M.	A. M. or P. M.	H. M.	H. M.	H. M.	H. M.	Min.	Min.	Feet.	Feet.		
1	May 12 L. W.	2	22 A. M.					—	19		2	250	
	May 12 H. W.	7	5 A. M.	4	43			—	17	21	17	38	14 910
	do 12 L. W.	2	23 P. M.			4	43	12	13		5	2	14 901
20	do 12 H. W.	7	26 P. M.	4	49					1	15	54	13 255
	do 13 L. W.	2	45 A. M.			17	12	5		17	2	90	12 615
	do 13 H. W.	7	53 A. M.	4	48			—	2	2	17	334	14 285
	do 13 L. W.	5	20 P. M.			17	12	10		17	2	80	15 245
25	do 13 H. W.	7	12 P. M.	4	12					17	15	18	12 176
	do 14 L. W.	5	5 A. M.			17	12	11		17	2	50	11 782
	do 14 H. W.	7	4 A. M.	4	4			—	19	17	12	144	14 441
	do 14 L. W.	4	1 P. M.			17	12	12		17	2	80	15 085
30	do 14 H. W.	7	12 P. M.	4	13					17	15	17	12 177
	do 15 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 15 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
	do 15 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
35	do 15 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
40	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
45	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
50	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
55	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
60	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
65	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
70	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
75	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
80	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
85	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
90	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
95	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177
100	do 16 L. W.	5	2 P. M.	4	15			—	17	17	15	17	12 177
	do 16 H. W.	7	4 P. M.	4	15			—	17	17	15	17	12 177

## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of losing tides No. VI.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).										Lunital intervals.		Oscillations of float in hundredths of a foot.		Wind.		Height of barometric column at sea level and for 0° cent or 32° Fah.	REMARKS.
Diurnal Inequalities.							Velocity miles per hour.	Direction.									
In duration of floods.	In duration of ebb.	In semi tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.			Inches								
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.									
					003	008											
16			019				6	27	2	5 875	N.E.	29 967	Fair, clear				
	13		1 636		314	032			3	6 136	E.	29 891	Raining hard				
26			640				6	27	2	6 386	E.	29 823	Raining very heavily		16		
8	18		2 370		149	081			1	6 591	E.	29 859	Rain ended at 4.0 a.m.				
40			390				6	8	2	5 181	S.E.	29 860	Raining quite heavily				
39	14		2 069		128	299			1	3 057	S.E.	29 900	Heavy rain continues				
41			814				6	3		1 807	E.	29 910	Still raining		17		
40	5		2 879		060	250			20	7 068	E.	29 884	Rain continues				
39			444				5	53	4	11 670	E.	29 859	do do				
47	2	*3	349		270	246			5	8 295	N.E.	29 935	{ Maximum diurnal inequality in high water levels observed = 3' 340 ft. Sky clearing up. Moon's N. declination a maximum = 21° 8'. Cloudy.				
21			150				5	44	4	7 613	N.E.	29 956		18			
15	8	2	249		137	355			3	7 693	N.E.	29 958	Sky overcast. Commencing to rain				
25			070				5	27	2	4 308	N.E.	29 951	Raining				
3	20	2	409		049	282			2	4 424	N.E.	29 898	Rain continues				
31			254				5	29		2 273	N.E.	29 868	do do		18		
15	18	1	809		281	217				909	S.W.	29 827	Cloudy				
27			599				5	14		1 898	W.	29 800	Weather clearing up				
8	29	2	799		271	356				7 159	W.	29 775	Clear, fair				
49			415				5	27		4 761	W.	29 812	Clouding up		20		
21	28	1	939		272	339				6 500	S.W.	29 854	Cloudy				
43			620				5	13		9 375	N.W.	29 871	Fair				
11	8	2	879		214	273			25	12 250	N.W.	29 911	Fine clear weather				
46			465				5	30		9 318	N.W.	29 959	do do		21		
42	12	2	420		003	157				8 181	N.W.	29 959	Fine bright morning				
35			315				5	20	2	11 470	N.	29 922	Fine and bright				
3	32	2	290		083	097				1 841	N.E.	29 906	Moon's first quarter, May 18th, at Quebec, from 6h. 5m. p.m. Clear and fine.				
37			579				5	41		2 163	N.E.	29 921		22			
13	19	2	300		202	032			5	6 886	N.E.	29 935	Cloudy				
							5	44	1	9 023	N.E.	29 920	Rain commenced at 11.40 a.m.				
24	487	236	33 967	5 644	2 546	3 024	85	47		180	201		866 892				
17	35	16	2 426	0 403	0 170	0 202	5	43		6 214			29 893				



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## APPENDIX 13.

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TIDAL FLUCTUATIONS, ETC.,

LEVIS GRAVING DOCK, HARBOUR OF QUEBEC,

DURING A COMPLETE LUNAR MONTH OF THE HIGH WATER SEASON  
OF 1888, VIZ., MAY 2nd TO JUNE 1st.

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### TABLE IX.

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WEEKLY SERIES OF GAINING TIDES, No. VII.

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## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of gaining tides No. VII.

DIRECT RESULT OF TIDAL OBSERVATIONS, &c.																	
Gauge book reference numbers. Series VII. Gaining tides.	High and low waters observed each civil day.	Time, Eastern Standard.			Duration of floods.		Duration of ebbs.		Length of half tide day H. W. to H. W.		Priming — or lagging — of tides.	Duration of apparent stand within 0.6 ft.	Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.
		H.	M.	A. M. or P. M.	H.	M.	H.	M.	H.	M.							
.....	May 19 H. W.	12	11	P. M.	..	..	..	..	..	..	17	..	15.165	..	..	..	..
.....	May 19 L. W.	7	52	P. M.	..	..	..	41	12	46	..	13	3.129	..	11.936	..	..
33	do 20 H. W.	12	50	A. M.	4	58	..	..	..	..	..	13	13.965	10.736	8.938	11.188	..
..	do 20 L. W.	5	25	A. M.	..	..	..	..	12	13	..	15	2.956	..	11.006	..	..
..	do 20 H. W.	1	12	P. M.	4	47	..	..	..	..	..	14	14.035	11.076	8.794	11.471	..
..	do 20 L. W.	6	4	P. M.	..	..	..	22	12	34	..	12	2.150	..	11.536	..	..
32	do 21 H. W.	12	6	A. M.	..	..	..	..	..	..	..	14	14.066	11.086	8.294	11.945	..
..	do 21 L. W.	7	55	A. M.	..	..	..	..	12	14	..	15	1.741	..	11.451	..	..
..	do 21 H. W.	1	56	P. M.	4	25	..	..	..	..	..	14	14.037	12.127	8.517	12.29	..
..	do 21 L. W.	7	1	P. M.	..	..	..	..	12	17	..	15	2.044	..	12.026	..	..
33	do 22 H. W.	12	2	A. M.	..	..	..	..	..	..	..	14	14.088	12.178	8.086	12.907	..
..	do 22 L. W.	7	25	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.116	..	..
..	do 22 H. W.	1	26	P. M.	4	24	..	..	..	..	..	14	14.065	12.126	8.617	13.551	..
..	do 22 L. W.	7	27	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
32	do 23 H. W.	12	27	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 23 L. W.	7	27	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 23 H. W.	1	28	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 23 L. W.	7	28	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
33	do 24 H. W.	12	28	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 24 L. W.	7	28	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 24 H. W.	1	29	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 24 L. W.	7	29	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
32	do 25 H. W.	12	29	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 25 L. W.	7	29	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 25 H. W.	1	30	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 25 L. W.	7	30	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
33	do 26 H. W.	12	30	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 26 L. W.	7	30	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 26 H. W.	1	31	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 26 L. W.	7	31	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
32	do 27 H. W.	12	31	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 27 L. W.	7	31	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 27 H. W.	1	32	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 27 L. W.	7	32	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
33	do 28 H. W.	12	32	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 28 L. W.	7	32	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 28 H. W.	1	33	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 28 L. W.	7	33	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
32	do 29 H. W.	12	33	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 29 L. W.	7	33	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 29 H. W.	1	34	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 29 L. W.	7	34	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
33	do 30 H. W.	12	34	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 30 L. W.	7	34	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 30 H. W.	1	35	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 30 L. W.	7	35	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
32	do 31 H. W.	12	35	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 31 L. W.	7	35	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 31 H. W.	1	36	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 31 L. W.	7	36	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
33	do 32 H. W.	12	36	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 32 L. W.	7	36	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 32 H. W.	1	37	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 32 L. W.	7	37	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
32	do 33 H. W.	12	37	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 33 L. W.	7	37	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 33 H. W.	1	38	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 33 L. W.	7	38	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
33	do 34 H. W.	12	38	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 34 L. W.	7	38	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 34 H. W.	1	39	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 34 L. W.	7	39	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
32	do 35 H. W.	12	39	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 35 L. W.	7	39	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 35 H. W.	1	40	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 35 L. W.	7	40	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
33	do 36 H. W.	12	40	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 36 L. W.	7	40	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 36 H. W.	1	41	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 36 L. W.	7	41	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
32	do 37 H. W.	12	41	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 37 L. W.	7	41	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 37 H. W.	1	42	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 37 L. W.	7	42	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
33	do 38 H. W.	12	42	A. M.	..	..	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 38 L. W.	7	42	A. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
..	do 38 H. W.	1	43	P. M.	4	22	..	..	..	..	..	14	14.088	12.228	8.084	14.057	..
..	do 38 L. W.	7	43	P. M.	..	..	..	..	12	19	..	15	1.741	..	12.121	..	..
32	do 39 H. W.	12	43	A. M.	..	..	..	..	..								

## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of gaining tides No. VII.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).										Wind.		Height of barometric column at sea level and for 0° cent. or 32° Fah.	REMARKS.
Diurnal In-qualities.													
In duration of floods.	In duration of ebbs.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.	Lunital intervals.						
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	H	M	Oscillations of float in hundredths of a foot.	Velocity miles per hour.	Direction.	Inches.	
	31			089									
29	11	1 200		094	172			3	5 455	N.E.	29 908	Sky clearing up.	
	18			270				5 57	3 398	N.W.	29 934	do	
9	17	070		394	243				10 307	N.W.	29 991	Clouds forming	
	19			760				5 54	6 659	N.W.	29 985	Sun showers	
47	32	030		000	414				8 045	N.W.	30 003	Clear weather	
	23			345				6 22	5 807	N.W.	30 083	Fair	
9	32	815		223	441			2	9 318	N.W.	30 108	Fine clear weather	
	4			340				6 18	1 012	N.W.	30 098	Beautiful day	
52	12	175		022	621				1 273	N.W.	30 174	Moon after crossing equator; fine	
	18			325				6 26	4 273	N.W.	30 218	night. Perfectly clear sky	
24	6	010		122	645				3 057	N.W.	30 236	Fine; clouds here and there	
	10			075				6 28	4 136	S.W.	30 148	Fine day; scattering clouds	
8	2	1 624		287	735				2 375	S.W.	30 103	Fair; sky getting cloudy	
	15			085				6 27	909	N.E.	30 085	do cloudy	
13	2	620		324	520				7 943	S.W.	30 021	Clear sky	
	14			210				6 27	5 170	S.W.	29 986	Rather close and hot	
9	5	1 930		396	474			2	6 955	N.E.	30 042	Fine and bright	
	21			050				6 22	6 304	E.	30 062	Very fine morning	
13	8	865		353	405			5	7 818	N.E.	30 034	Moon in perigee, May 24th, at 2 p.m.;	
	18			250				6 25	4 716	N.E.	29 993	fine. Fine and bright	
4	14	1 999		221	323			4	9 545	N.E.	29 995	do clear weather	
	28			130				6 12	6 534	N.E.	30 006	Full moon (Quebec) May 25th, at 5h, 28	
16	12	1 599		140	199			4	9 068	N.E.	30 004	40m., p.m.; fine day	
	21			210				6 11	10 273	N.E.	30 002	Fine day; sky clear of clouds	
13	8	2 154		056	151			10	7 216	N.E.	30 021	Fine clear night	
	24			250				6 2	5 602	N.E.	30 035	Clear sky; fine	
11	13	2 184		090	082				3 807	N.E.	29 922	Fair	
								6 5	8 841	N.E.	29 906	Clouding up	
24	364	174 15 295	3 389	2 602	5 425	87 36			165 876		841 163		
18	19	12 1 032	0 242	0 192	0 387	6 15			5 924		30 042		

## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of gaining tides No. VII.

RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."																	
Gauge book reference num-ber. Series VII. Gaining tides.	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.					Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2). †		Length of half tide day H. W. to H. W.		Priming — or lag- ging + of tides.	Lunital intervals		General coefficients of semi-amplitudes from "l'Annuaire des Mares," cor-responding to observed tides assumed to be 48 hours old, together with pro-portional amplitudes and diurnal in-equalities.*				
	Upper passage.		Lower passage.		Ages, &c.	H.	M.	H.	M.		H.	M.	Co-efficients.	*Ampli-tudes.  Feet.	Diurnal Differences		
	H.	M.	H.	M.											Days.	In ampli-tudes.  Feet.	In semi-tide days.  Min.
1							C.			+ 22							
2								12	38						02		
23	6	53				12	58				5	44	46	8 55			
3						12	20	12	40						37		
4			7	18	9 6	1	37			+ 29	5	59	48	8 92		1	
5						12	53	12	39						54		
24	7	44				2	16				6	12	51	9 46			
6						1	56	12	37						93		
7						2	30										
8			8	10	10 6	2	50			+ 21	6	23	56	10 39			
9						2	33	12	34						1 14		
25	8	36				3	9										
10						3	28	12	31								
11					11 6	3	48										
12						2	7	12	31						1 30		
13			9	2		3	55			+ 9	6	36	69	12 83			
14						3	32	12	28						1 30		
26	9	29				4	24										
15						4	6										
16					12 6	4	55	12	26								
17						4	31								1 27		
18			9	57		4	32			+ 1	6	35	83	15 40			
19						4	27	12	25						1 15		
27	10	25				4	50										
20						4	57				6	32	89	16 55			
21					13 6	4	56	12	24						1 12		
22			10	53		5	4			— 2	6	28	95	17 7			
28	11	23				5	21										
23					0	5	38	12	24				100	18 56			
24					14 6	5	45								89		
25						5	46	12	24						78		
26			11	53		6	3			— 3	6	16	104	19 34			
27						6	9										
28						6	0	12	23						37		
29		23				6	28				6	9	106	19 71			
30					15 6	6	32										
31						6	35	12	23						19		
32						6	51			— 3	6	1	107	19 90			
33					54	7	55										
34						7	0										
Totals 14 tides.	66	53	70	7	.....	69 + 156 = 225	25	174	56	+ 60 ..... + 8 + 13 — 3	88	25	1092	203 94	11 37		
Means 14 tides.	9	33	10	1	.....	16	6	12	30	.....	6	19	78 00	14 57	81		

\* The ratio of the mean of the observed amplitudes to the mean of the coefficients being taken as the ratio of computation, or say 18 6 ft. = 1 00.

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## APPENDIX 13.

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TIDAL FLUCTUATIONS, ETC.,

LEVIS GRAVING DOCK, HARBOUR OF QUEBEC,

DURING A COMPLETE LUNAR MONTH OF THE HIGH WATER SEASON  
OF 1888, VIZ., MAY 2 TO JUNE 1.

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### TABLE IX.

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WEEKLY SERIES OF LOSING TIDES, No. VIII.

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## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of losing tides No. VIII.

Gauge book reference numbers Series VIII. Losing tides.		High and low waters observed each civil day.	DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.														Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.		
			Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide day H.W. to H.W.		Priming — or lagging + of tides.	Duration of apparent stand with in 0.06 ft.	Elevations of sun, moon and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.					
			H.	M.	A.M. or P.M.	H.	M.	H.	M.	Min.						Min.			Feet.	Feet.
30	May 26	H.W.	6	59	P.M.						— 7		17.444							
	May 27	L.W.	2	36	A.M.			7	37	12	9	17	2.408	15.085						
	do	27	H.W.	7	8	A.M.	4	32				19	20.184	17.775	10.529	16.311				
	do	27	L.W.	3	29	P.M.			8	21	12	36	15	2.339	17.845					
31	do	27	H.W.	7	44	P.M.	4	15			— 2	20	16.926	14.587	10.344	15.921				
	do	28	L.W.	3	21	A.M.			7	37	12	12	16	2.389	14.537					
	do	28	H.W.	7	56	A.M.	4	35				18	19.263	16.874	10.016	15.637				
	do	28	L.W.	4	17	P.M.			8	21	12	35	17	1.989	17.274					
32	do	28	H.W.	8	31	P.M.	4	14			— 4	19	15.924	13.935	9.790	15.321				
	do	29	L.W.	4	8	A.M.			7	37	12	19	16	2.259	13.665					
	do	29	H.W.	8	50	A.M.	4	42				19	18.633	16.374	9.656	14.924				
	do	29	L.W.	5	6	P.M.			8	16	12	35	19	2.064	16.569					
33	do	29	H.W.	9	25	P.M.	4	19			— 5	12	15.414	13.350	9.420	14.582				
	do	30	L.W.	5	20	A.M.			7	55	12	10	13	2.234	13.190					
	do	30	H.W.	9	35	A.M.	4	15				20	17.304	15.070	9.020	14.164				
	do	30	L.W.	5	53	P.M.			8	18	12	52	15	1.659	15.645					
34	do	30	H.W.	10	27	P.M.	4	34			+ 7	20	14.355	12.696	8.824	13.457				
	do	31	L.W.	5	47	A.M.			7	20	12	5	23	2.564	11.791					
	do	31	H.W.	10	32	A.M.	4	45				23	16.132	13.568	8.640	12.832				
	do	31	L.W.	6	36	P.M.			8	4	12	45	20	1.864	14.268					
35	do	31	H.W.	11	17	P.M.	4	41			+ 14	29	13.645	11.781	8.704	12.337				
	June 1	L.W.	6	35	A.M.			7	18	12	19	17	3.189	10.456						
	do	1	H.W.	11	36	A.M.	5	1				28	16.104	12.915	8.965	12.608				
	do	1	L.W.	7	28	P.M.			7	52	12	54	18	2.734	13.370					
36	do	2	H.W.	12	30	A.M.	5	2			— 1	29	14.020	11.286	8.781	11.907				
	do	2	L.W.	7	44	A.M.			7	14	11	57	23	3.323	10.697					
	do	2	H.W.	12	27	P.M.	4	43				22	13.995	10.672	8.188	11.115				
	do	2	L.W.	8	26	P.M.			7	50	13	12	21	1.899	12.096					
Totals 14 tides	do	3	H.W.	1	39	A.M.	5	13			+ 29	34	13.057	11.158	7.908	10.532				
	June 3	L.W.	8	46	A.M.			7	7	12	7	21	2.749	10.308						
	H.W.	129	37					64	51	116	56	47	— 56	312	224.966	192.041	206.736	128.775	190.872	
	L.W.	85	32									— 7	269	32.915						
Means	do	14 H.W.									+ 11	22	16.068							
Grand totals 57 tides	do	15 L.W.						4	38	7	48	25	— 3	18	2.351	13.718	13.782	9.198	13.641	
	H.W.							270	41	436	57	707	21	— 175	1366	888.611	757.426	756.257	510.417	756.906
	L.W.											— 163	1181	127.315						
	H.W.							4	45	7	40	12	25	+ 12	24	15.590	13.288	13.268	9.955	13.279
Grand means 57 tides	L.W.											— 12	20	2.233						

N.B.—Maxima in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °

## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of losing tides No.VIII.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).							Lunatic intervals.		Wind.		Height of barometric column at sea level and for 0° cent or 32° Fahr.	REMARKS.	
Diurnal Inequalities.													
In duration of floods.	In duration of ebb.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In ampli- tudes.	H.	M.	Oscillations of float in hun- dreds of a foot.	Velocity, miles per hour.	Direction.	Inches.	
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.							
14	39	15	2 740	350	075	131			19	7 807	N.E.	29 895	Cloudy
	44			070			5	43		5 341	N.E.	29 924	Commencing to rain.
17	25	15	3 258		185	349				4 750	N.E.	29 891	Raining
	44			059			5	49	1	5 636	N.E.	29 913	Moon's S. declination a maximum=21° 41'. Rain continues.
20		24	2 337		328	306				3 429	N.E.	29 912	Rain stopped at 9.0 p.m.; cloudy.
	44			400			5	31		2 511	N.E.	29 907	Rain; cloudy
21		23	3 339		236	343			10	6 307	N.E.	29 885	do
	44			270			5	37		2 239	N.E.	29 890	Rain continues; sky overcast.
28		16	2 709		124	322			10	5 216	N.E.	29 870	Rain
	39			195			5	27	1	3 136	S.W.	29 693	Raining still.
23		16	3 219		226	448			1	4 205	S.W.	29 716	Fine, bright, warm afternoon.
	21			170			5	34		875	S.W.	29 761	Fine, clear weather.
4		25	1 800		400	394				2 318	S.W.	29 803	Fine morning.
	23			575			5	17		3 898	W.	29 781	Clear, bright, sunny day.
19		42	2 949		166	723			10	7 045	W.	29 754	Squalls of W. wind.
	58			935			5	43		2 023	W.	29 803	Clear, fine night.
11		47	1 777		184	573				1 705	E.	29 923	Cloudy and cool.
	16			700			5	23		2 511	N.E.	29 936	Fair
4		40	2 487		064	497				2 162	N.E.	29 897	Cloudy.
	40			1 325			5	45		2 511	N.E.	29 779	Rain commenced at 11 p.m.
9		26	2 459		261	349			6	7 989	N.E.	29 598	Moon's last quarter, June 1st, at Que- bec, from 7h. 53m. a.m.; pouring rain.
	34			455			5	40	6	6 250	S.W.	29 586	Clearing up
1		36	2 084		184	499				2 693	S.	29 621	do
	38			589			6	12		2 150	S.	29 688	Sky becoming cloudy
19		57	025		593	351				2 466	N.E.	29 804	Cloudy, mist and rain.
	45			1 424			5	46		1 443	N.E.	29 809	Sky clearing up; fair.
30		55	938		280	404				5 330	N.E.	29 808	Cloudy
	52			850			6	37		2 977	N.E.	29 806	Rain; sky overcast.
13		65	803		280	404				1 648	W.	29 807	Rain continues
224	567	545	33 014	8 328	3 626	6 093	80	4		108 532		865 370	
15	39	36	2 201	555	242	406	5	43		3 743		29 840	
836	1624	1180	96 971	24 271	11 407	18 498	350	52		667 128		3413 555	
14	28	21	1 701	426	294	325	6	10		5 888		29 943	

## APPENDIX 13.—Tidal Fluctuations, Lévis Graving Dock, series of losing tides No. VIII.

Gauge book reference numbers. Series VIII. Losing tides.		RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."														
Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.						Eastern standard civil times of high water at Québec, based on first times: (No. 2.) †		Length of half tide day H.W. to H.W.		Priming — or lagging + of tides.	Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old, together with proportional amplitudes and diurnal inequalities.*			
Upper passage.		Lower passage.		Ages, &c.	Days.	H.	M.	H.	M.				Co-efficients.	*Ampli- tudes. Feet.	Diurnal Differences	
H.	M.	H.	M.								In ampli- tudes. Feet.	In semi- tide day. Min.				
										— 3						
								12	24						19	
30	1	25			16 6	7 7	14 23				5 54	106	19 71		1	
						7 7	38 46			— 3	5 47	104	19 34		1	
			1	55		7 7	42 46	12	24							
						8 8	6 11				5 41	101	18 78		0	
31	2	25			17 6	8 8	27 30			— 3	5 36	96	17 85		1	
			2	54		8 8	34 34	12	23							
						8 8	52 53				5 30	91	16 92		0	
32	3	23			18 6	8 8	59 15	12	23							
						9 9	16 24			— 3	5 25	85	15 81		1	
			3	51		9 9	40 47	12	24							
33	4	18			19 6	9 9	4 6				5 22	79	14 69		2	
						9 9	12 12	12	26							
			4	44		10 10	29 32			+ 2	5 22	72	13 39		0	
						10 10	38 38	12	26							
34	5	9			20 6	10 10	55 59				5 23	66	12 27		1	
						10 10	1 1	12	27							
			5	32		10 10	23 29			+ 7	5 27	60	11 16		3	
						11 11	51 55	12	30							
35	5	56			21 6	11 11	1 1				5 33	55	10 23		2	
						11 11	29 32	12	32							
			6	18		12 12	51 55			+ 17	5 43	51	9 48		3	
						12 12	53 53	12	35							
36	6	41			22 6	12 12	36 36				5 55	48	8 92		4	
						12 12	23 23	12	31							
			7	2		1 1	26 27			+ 10	6 5	46	8 53			
					23 6	12 12	53 53	12	29							
Total 14 tides	29	17	32	16		128 16	140 16	186 41		+ 36	78 43	1060	197 8	1137	19	
Mean 14 tides	4	11	4	37		10 1	12 27			+ 9 — 3	5 37	75 71	14 8	81	1	
Grav'd tides 57	179	25	198	37		573 4	707 42			+ 178 — 164 — 14 — 10	351 2	4071	757 72	3653	94	
Grav'd m'n 57 tides	6	24	6	51		10 3	12 25				6 10	77 42	13 29	65	2	

\* The ratio of the mean of the observed amplitudes to the mean of the coefficients being taken as the basis of computation, or say 186 ft=100.

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## APPENDIX 13.

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TIDAL FLUCTUATIONS, ETC.,

\*CHAUDIERE, ST. NICHOLAS, POINTE PLATON,

DURING A COMPLETE LUNAR MONTH OF THE HIGH WATER SEASON  
OF 1888, VIZ., MAY 2 TO JUNE 1.

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### TABLES X, XI AND XII.

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WEEKLY SERIES OF GAINING AND LOSING TIDES Nos. V, V, VI, VII, VIII.

\*Chaudière fluctuations incomplete.

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## APPENDIX 13.

TABLE X.—Tidal Fluctuations at Chaudière during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																											
Gauge being reference instrument. Station V. Gauging table.		High and low waters observed each civil day.		Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide-day H.W. to H.W.		Priming or lagging of tides Duration of apparent stand within 0.05 feet.		Elevations of summits and troughs of fluvial tide waves.		Ranges of floods.		Ranges of ebbs.		Mean tide levels corrected for diurnal inequalities.		Mean amplitudes corrected for diurnal inequalities.		In duration of floods.		In duration of ebbs.	

## APPENDIX 13.

TABLE X.—Tidal Fluctuations at Chaudière during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."														
Diurnal Inequalities.					Lunital intervals.		Oscillations of float in hundredths of a foot.		Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)		Length of half tide day H.W. to H.W.		Priming—or lagging + of tides		Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Mares," corresponding to observed tides assumed to be 48 hours old.		Series V. Gaining tides. Gauge book reference numbers.		
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.					Upper passage.	Lower passage.	Ages, etc.													
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.								
									23 3					12 42										
29		950			7	5			7 37			2 16		+ 33	6 39		44							
33	1 430		241	153										12 41										9
	540		620		6	58			7 59			2 57			6 58		46							
29		110	069	370	7	24			8 21			3 34		+ 19	7 13		49							
19		660		159	7	22			8 42			4 6			7 24		53							10
17		230	121	648		2						25 3												
	400		216	322	7	38			9 4			4 33		+ 2	7 29		57							
7		340			7	39			9 24			4 58			7 34		61							11
11	560		064	227		3						26 3												
	810		060	171	7	32			9 45			5 20		— 8	7 35		65							
20		150			7	36			10 6			5 40			7 34		69							12
23	1 160		076	272		3						27 3												
	660		321	253	7	21			10 26			5 58		— 14	7 32		72							
22		660			7	34			10 48			6 16			7 28		75							13
15	1 950		630	120		5						28 3												
	480		587	102	7	21			11 9			6 32		— 17	7 23		78							
14		590			7	22			11 31			6 49			7 18		80							14
	1 560		104	030		5						29 3												
14		350			7	9			11 53			7 4		— 19	7 11		81							
	2 280		200	025		3																		
2		000			7	10			15			7 20			7 5		82							15
	2 100					3						0 6												
257	14 190	5 850	2 848	2 925	103	11	...		58 45	68 15	...	73 23	173 19	+ 54	102 23	912								
														— 58										
19	1 014	0 418	0 219	0 225	7	22	...		8 21	9 45	...	5 15	12 23	+ 18	7 19	65 14								
														— 15										

‡ Moon crosses the equator.

§ Moon in apogee, May 9th, at 8h. 0m. p.m.

New moon (Quebec) May 10th, at 8h. 24m. p.m.

## APPENDIX 13.

TABLE XI.—Tidal Fluctuations at St. Nicholas during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

Gauge book reference numbers. Series V. Gaining tides.		DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
		High and low waters observed each civil day.	Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide day H. W. to H. W.		Priming—or lagging + of tides.		Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	In duration of floods.		In duration of ebbs.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
			H.	M.	A.M. or P.M.	H.	M.	H.	M.	H.	M.	Min						Min	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Min.	Min.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
9 + 10 + 11 + 12 + 13 + 14 + 15	May 4	L.W.	9	50	P.M.			7	50	13	0		20	2-8392																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														</

N.B.—Maxima in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °.

## APPENDIX 13.

TABLE XI.—Tidal Fluctuations at St. Nicholas during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).										RESULT BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."											
Diurnal Inequalities.					Lunital intervals, Oscillations of float in hundredths of a foot.		Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding gages and phases of the moon.				Eastern standard civil times of high water at Quebec, based on Brest times: No. 24		Length of half tide day H. W. to H. W.		Priming — or lagging + of tides.		Lunital intervals.		General coefficients of semi-amplitudes from "L'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.		Series V. Gaining tides, Gauge book reference numbers.
In semi tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.			Upper passage.	Lower passage.	Ages, etc.												
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min	H.	M.					
									23 3				12 42				+				
45	1 3300	8500	2400	1000	7 23	1		7 37				2 36	*12 41	+33	6 59		44				
25		4500	4700	0325	3150	7 15		8 0		24 3		3 17	12 37		7 17		46		9		
20		0900		1462	2475	7 34		8 21				3 54	12 32	19	7 33		49				
20		6300		1063	6275	7 32		8 43		25 3		4 26	12 27		7 43		53		10		
25		2200	2100			* 7 51		9 4				4 53	12 25	+ 2	7 49		57				
6	0	3200	3700	2000	2400	7 45		9 25		26 3		5 18	12 22		7 53		61		11		
10		4200	3800	0638	1375	7 39		9 46				5 40	12 20	8	* 7 54		65				
15		6300	1800	0175	1650	7 43		10 7		27 3		6 0	12 18		7 53		69		12		
25	0	1 1000	1900	1200	2500	7 34		10 26				6 18	12 18	14	7 52		72				
50		5900		3312	2125	7 41		10 49		28 3		6 36	12 16		7 47		75		13		
10	1 8300	6300	0700			7 30		11 10				6 52	12 17	17	7 42		78				
50	10	4100	5800	0800		7 29	15	11 31		29 3		7 9	12 15		7 38		80		14		
10	5	4700	1200	0100		7 7	12	11 53	●			7 24	12 16		7 31		81				
0	10	2 0700	2800	1487	0475	7 24	12	16		0 6		7 40	12 15		7 24		82		15		
5	10	9800	0300	1400	0100		15														
100	35 2	8900	5 4000	2 8762	2 5125	105 27	...	58	51 68	17	...	78 3	173 19		106 55		912				
7	2	9207	3857	2054	1795	7 32	...	8	24 9	45	...	5 35	12 23		7 38		65 14				

† Longitude, St. Nicholas gauge =  $71^{\circ} 23'$ , 4h, 45m, 32s, = 0.1983 of a day west of Greenwich.

<sup>†</sup> Longitude, on aneroid gauge = 14. 20', 4m. alt. 625, = 6, 1000 ft. a day west of Greenwich.

## APPENDIX 13.

TABLE XI.—Tidal Fluctuations at St. Nicholas during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																											
Gauge book reference numbers. Series VI. Losing tides.		High and low waters observed each civil day.	Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide day H. W. to H. W.		Priming—or lagging + of tides		Duration of apparent stand within 0.05 feet.		Elevations of summits and troughs of fluvial tide waves.		Ranges of floods.		Ranges of ebbs.		Mean tide levels corrected for diurnal inequalities.		Mean amplitudes corrected for diurnal inequalities.		Diurnal In-equalities.		
			H.	M.	A.M. or P.M.	H.	M.	H.	M.	H.	M.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Min.	Min.	Min.	Min.		
16	May 12	H. W.	7 40	A.M.	4 50							- 10		3 9192													
	do 12	L. W.	3 20	P.M.			7 40	12 30				- 20		17 18 1992	14 2800					10 7080	13 3375						
	do 12	H. W.	8 10	A.M.	4 50									9 4 1592						14 0400					00		
	do 13	L. W.	3 10	A.M.			7 0	11 55						- 22 16 8892	12 7300					11 1405	13 2525				40		
17	do 13	H. W.	8 5	A.M.	4 55							- 25		4 8692						12 0200					5		
	do 13	L. W.	4 0	P.M.			7 55	12 30						19 0892	14 2200					11 3805	13 1025				20	55	
	do 13	H. W.	8 35	P.M.	4 35									16 6592	11 8700					11 3119	13 1346				30		
	do 14	L. W.	4 0	A.M.			7 25	12 25						4 7000						11 9592				* 25			
18	do 14	H. W.	9 0	A.M.	5 0							- 15		19 1092	14 4092							12 8496			5		
	do 14	L. W.	4 30	P.M.			7 30	12 10				- 20		5 1892						13 9200	11 3694				20		
	do 14	H. W.	9 10	P.M.	4 40									16 2992	11 1100							12 3275			20		
	do 15	L. W.	4 20	A.M.			7 10	12 0						5 1292						11 1700	11 3230				10		
19	do 15	H. W.	9 10	A.M.	4 50							- 20		18 2392	13 1100							12 0100			40		
	do 15	L. W.	5 0	P.M.			7 50	12 30						5 1492						13 0900	11 1442				10		
	do 15	H. W.	9 40	P.M.	4 40									15 8192	10 6700							11 7625			30		
	do 16	L. W.	5 0	A.M.			7 20	12 20						5 1692						10 6500	11 0405				20		
20	do 16	H. W.	10 0	A.M.	5 0							+ 10		17 8092	12 6400							11 6600			30		
	do 16	L. W.	5 50	P.M.			7 50	12 40						4 6692						13 1400	10 7492				10		
	do 16	H. W.	10 40	P.M.	4 50									14 8792	10 2100							11 3875			50		
	do 17	L. W.	5 40	A.M.			7 0	12 5						4 8192						10 0600	10 4390				15		
21	do 17	H. W.	10 45	A.M.	5 5							+ 5		16 9592	12 1400							11 1475			55		
	do 17	L. W.	6 40	P.M.			7 55	12 50						4 2492						2 7100	10 1080				10		
	do 17	H. W.	11 35	P.M.	4 55									13 9292	9 6800							10 9200			65		
	do 18	L. W.	6 25	A.M.			6 50	12 0						4 5792						9 3500	9 8742				15		
22	do 18	H. W.	11 35	P.M.	5 10							+ 5		16 5192	11 9400							10 8200			65		
	do 18	L. W.	7 30	P.M.			7 55	12 55						4 2992						12 2200	9 8492				10		
	do 19	H. W.	12 30	A.M.	5 0									14 0692	9 7700							10 7275			55		
	do 19	L. W.	7 30	A.M.			7 0	12 20						4 8392						9 2300	9 9330				20		
		do 19	H. W.	12 50	P.M.	* 5 20						+ 10		16 5292	11 6900							10 7025			40		
		Totals 15 tides.	H. W. 149 25			73 40	104 20	173 10			+ 30	39	250 9980		180 4692	157 8592	160 5851	179 1417	190 590								
		L. W.	72 55								- 80	9	70 5288														
		Means 15 H. W.				4 55	7 27	12 22			+ 8	19	16 7332		12 0313	11 2757	10 7057	11 9428	14 42								
		14 L. W.									- 20	9	4 7017														

N.B.—Maxima in whole lunar month indicated by a star thus : \* and minima by a circle thus : °

† Moon's N. declination a maximum.

‡ Moon's first quarter (Quebec) May 18th, from 6h. 5m. p.m.

## APPENDIX 13.

TABLE XI.—Tidal Fluctuations at St. Nicholas during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF  
TIDAL OBSERVATIONS—(Continued).

RESULTS BASED ON DATA FROM  
NAUTICAL ALMANAC  
AND "L'ANNUAIRE DES MARÉES."

Diurnal Inequalities.						Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.										Eastern standard civil times of high water at Quebec, based on Brest times. (No. 2.)												Length of half tide day H. W. to H. W.												Priming—or lagging + of tides														Lunital intervals.														General coefficients of semi-amplitudes from "l'Annuaire des Mers," corresponding to observed tides assumed to be 48 hours old.																Series VI. Losing tides, Gauge book reference numbers.																																																																																																																																																																																																																																																																																																																																															
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## APPENDIX 13.

TABLE XL.—Tidal Fluctuations at St. Nicholas during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																										
Gauge book reference numbers. Series III. (gaining tides.)	High and low waters observed each civil day.	Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide day H.W. to H.W.		Priming—or lagging + of tides		Duration of apparent stand within 0.05 feet.		Elevations of summits and troughs of fluvial tide waves.		Ranges of floods.		Ranges of ebbs.		Mean tide levels corrected for diurnal inequalities.		Mean amplitudes corrected for diurnal inequalities.		Diurnal Inequalities		
		H.	M.	A.M. OR P.M.	H.	M.	H.	M.	H.	M.	Min	Min	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Min.	Min.						
											+10		16 5292													
23	May 19 L.W.	8	30	P.M.				7	40	12	40			4 8892		11 6400								20		
	do 20 H.W.	1	30	A.M.	5	0							13 15 1392	10 2500		10 1055	10 8525						10			
24	do 20 L.W.	9	0	A.M.				7	30	12	50			20 4 4692		10 6700							20			
	do 20 H.W.	2	20	P.M.	5	20						+40	23 15 3192	10 8500		9 7030	11 1675						10			
25	do 21 L.W.	9	40	P.M.				7	20	12	40			13 3 7692		11 5500							0			
	do 21 H.W.	3	0	A.M.	5	20							23 15 3692	11 6000		9 7380	11 6075						10			
26	do 21 L.W.	10	10	A.M.				7	10	12	10			4 0992		11 2700							20			
	do 21 H.W.	3	10	P.M.	5	0						0	16 1092	12 0100		9 9267	12 0850						35			
27	do 21 L.W.	10	55	P.M.				7	45	12	40			3 6692	12 4400								5			
	do 22 H.W.	3	50	A.M.	4	55							16 2892	12 6200		9 9180	12 6175						5			
28	do 22 L.W.	11	30	A.M.				7	40	12	25			3 5492	12 7400								10			
	do 22 H.W.	4	15	P.M.	4	45						5	16 2192	12 6700		10 0655	13 1225						5			
29	do 22 L.W.	11	50	P.M.				7	35	12	20			3 4592	12 7600								0			
	do 23 H.W.	4	35	A.M.	4	45							17 7792	14 3200		10 3642	13 7800						20			
30	do 23 L.W.	12	30	P.M.				7	55	12	35			3 4692	14 3100								5			
	do 23 H.W.	5	10	P.M.	4	40						+5	17 1992	13 7300		10 6942	14 1800						25			
31	do 24 L.W.	12	40	A.M.				7	30	12	20			3 7392	13 4600								10			
	do 24 H.W.	5	30	A.M.	4	50							18 9592	15 2200		11 0692	14 5100						20			
32	do 24 L.W.	1	20	P.M.				7	50	12	30			3 8892	15 0700								10			
	do 24 H.W.	6	0	P.M.	4	40						10	18 1792	14 2900		11 4030	14 8375						20			
33	do 25 L.W.	1	30	A.M.				7	30	12	10			4 0792	14 1000								0			
	do 25 H.W.	6	10	A.M.	4	40							19 9692	15 8900		11 6167	15 1150						40			
34	do 25 L.W.	2	20	P.M.				8	10	10	40			17 4 0392	15 9300								10			
	do 25 H.W.	6	50	P.M.	4	30						+10	15 18 5792	14 5400		11 7535	15 2325						40			
35	do 26 L.W.	2	20	A.M.				7	30	12	20			14 4 2392	14 3400								20			
	do 26 H.W.	7	10	A.M.	4	50							14 20 3592	16 1200		11 8030	15 2975						30			
36	do 26 L.W.	3	10	P.M.				8	0	12	30			16 4 0692	16 2900								20			
	do 26 H.W.	7	40	P.M.	4	30						10	14 18 5092	14 4400		11 8780	*15 4175						30			
Totals 14 tides.		H.W.	67	10	+12=						+55		126 243 9788	188 5500	186 5700	150 0285	189 8225	150 300								
L.W.		107	23	+12			67	45	107	5	174	50	—25 76 55 4288													
Means		14 H.W.									+18		18 17 4271	13 4679	13 3265	10 7163	13 5588	11 21								
do		14 L.W.									—6		15 3 9592													

N.B.—Maxima in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °

## APPENDIX 13.

TABLE XI.—Tidal Fluctuations at St. Nicholas during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued.)						RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."												General coefficients of semi-amplitudes from "l'Annuaire des Mares," cor- responding to observed tides assum- ed to be 48 hours old.	Series III. Gaining tides. Gauge book reference numbers.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
Diurnal Inequalities.					Lunital intervals, Oscillations of float in hundredths of a foot.		Eastern standard civil times of meridian passages immediately pre- ceding observed high waters, with corresponding ages and phases of the moon.					Length of half tide day H. W. to H. W.		Priming—or lagging + of tides		Lunital intervals.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.			Upper passage.		Lower passage.		Ages, etc.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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†Moon after crossing equator.

‡Moon in perigee, May 24th, at 2h. 0m. p.m.

§Full moon (Quebec) May 25th, at 8h. 40m. a.m.

## APPENDIX 13.

TABLE XI.—Tidal Fluctuations at St. Nicholas during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																									
Gauge book reference numbers, Series VIII. Lowing tides.	High and low waters observed each civil day.	Time, Eastern Standard.	Duration of floods.		Duration of ebbs.		Length of half tide-day H.W. to H.W.		Priming or lagging + of tides	Duration of apparent stand within 0 06 feet.	Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	In duration of floods.									
			A.M.		H. M.		H. M.										H. M.		Min.	Min.	Feet.	Feet.	Feet.	Feet.	Min.
			H.	M.	H.	M.	H.	M.									H.	M.							
										10															
30	May 27 L.W.	3 10 A.M.			7 30	12 10			12	4 2692		14 2400					10								
	do 27 H.W.	7 50 A.M.	4 40						12	*20 9692	*16 7000		*11 9517	15 3060											
	do 27 L.W.	4 0 P.M.			8 10	12 45			14	4 3292		*16 6400				5									
31	do 27 H.W.	8 35 P.M.	4 35					0		17 9692	13 6400		11 8367	14 8450		5									
	do 28 L.W.	4 0 A.M.			7 25	12 5				4 4992		13 4700				5									
	do 28 H.W.	8 40 A.M.	4 40						20	1292	15 6300		11 5092	14 5900		10									
32	do 28 L.W.	5 0 P.M.			8 20	12 50				3 9292		16 2000				10									
	do 28 H.W.	9 30 P.M.	4 30					0		16 9892	13 0600		11 1805	14 4625		15									
	do 29 L.W.	4 45 A.M.			7 15	12 0				3 9692		13 0200				15									
33	do 29 H.W.	9 30 A.M.	4 45						19	5392	15 5700		11 0230	14 2575		10									
	do 29 L.W.	5 45 P.M.			8 15	12 50				3 8192		15 7200				10									
	do 29 H.W.	10 20 P.M.	4 35					0		16 5392	12 7200		10 8205	13 8325		15									
34	do 30 L.W.	5 30 A.M.			7 10	12 0				3 9892		12 5500				15									
	do 30 H.W.	10 20 A.M.	4 50						18	3292	14 3400		10 4470	13 6175		10									
	do 30 L.W.	6 30 P.M.			8 10	12 50				3 2892		15 0400				10									
35	do 30 H.W.	11 10 P.M.	4 40					0		15 8292	12 5400		10 2257	13 1621		10									
	do 31 L.W.	6 20 A.M.			7 10	12 0				4 0000		11 8292				10									
	do 31 H.W.	11 10 A.M.	4 50						17	2392	13 2392		10 0107	12 5721		10									
36	do 31 L.W.	7 10 P.M.			8 0	*13 0				3 4492		13 7900				10									
	do 31 H.W.	12 10 A.M.	5 0					20	20	14 8792	11 4300		10 0167	12 0750		20									
	June 1 L.W.	7 0 A.M.			6 50	12 10			10	4 5092		10 3700				20									
37	do 1 H.W.	12 20 P.M.	5 20						23	17 2192	12 7100		10 2830	11 7775		20									
	do 1 L.W.	8 10 P.M.			7 50	12 50			22	4 2792		12 9400				20									
	do 2 H.W.	1 10 A.M.	5 0					10	22	15 3692	11 0900		10 1306	11 3125		0									
38	do 2 L.W.	8 20 A.M.			7 10	12 10				4 6692		10 7000				0									
	do 2 H.W.	1 20 P.M.	5 0						15	1892	10 5200		9 5142	11 0600		20									
	do 2 L.W.	9 0 P.M.			7 40	13 0				3 2292		11 8900				20									
39	do 3 H.W.	2 20 A.M.	5 20					30		14 4292	11 1300		9 2255	11 1325		10									
	do 3 L.W.	9 30 A.M.			7 10	12 20				4 0192		10 4100				10									
Totals 14 tides.			116 25	+24	67 45	114 5 187	0	60	77 240	6188		184 3192	198 8092	148 1749	184 0017	170									
L.W.			140 25					0	44 56	2996															
			94 10																						
Means					4 50	7 36	12 28	15	19 17	1871		13 1657	13 2539	10 5840	13 1430	12									
do								0	15 4	0214															
Grd. totals H.W.								185	76 953	4244															
57 tides					278 25	429 15 707	40					727 7884	716 6084	590 0473	727 6334	610									
L.W.								155	56 222	7968															
37 H.W.								13	19 16	7267															
Grd. means do					4 53	7 32	12 25				12 7682	12 5721	10 3516	12 7655	11										
37 L.W.								10	14 3	9087															

N.B.—Maxima in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °

† Moon's S. declination a maximum = 21° 41'.

‡ Maximum diurnal inequality in high water levels observed = 3 1400 feet.

## APPENDIX 13.

TABLE XI.—Tidal Fluctuations at St. Nicholas during the High water season of 1888, viz.:—from quadrature May 2nd, to quadrature June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."									
Diurnal Inequalities.										Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.									
In duration of ebb.	In semi-tides days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.	Lunital intervals.		Oscillations of float in hundredths of a foot.		Upper passage.	Lower passage.	Ages, etc.	Eastern standard civil times of high water at Quebec, based on Brest times; No. 2.	Length of half tide day H. W. to H. W.	Priming — or lagging + of tides.	Lunital intervals.		General coefficients of semi-amplitudes from "L'Annuaire des Marées," corresponding to observed tides assumed to be 16 hours old.	
Min	Min	Feet.	Feet.	Feet.	Feet.	H.	M.			H.	M.	H.	M.	H.	M.	H.	M.		
			2000												3				
40	35	2 4600	0600	0737	1125	6	25	12	1 25				8 1	12 24		6 36	106	30	
45	40	3 0000	1700		4600	6	39	10	1 56				8 24	12 23	3	6 28	104		
55	45	2 1600		3275	2550	6	14	10	2 26				8 48	12 24		6 22	101	31	
65	50	3 1400	0400		3287	6	35	10	2 55				9 12	12 23	3	6 17	96		
60	50	2 5500	1500		1575	6	6		3 24				9 35	12 23		6 11	91	32	
65	50	3 0000		2025	4250	6	28		3 52				9 58	12 23	3	6 6	85		
60	50	1 7900	7000	3735	2150	6	2	4 18					10 22	12 24		6 4	79	33	
60	50	2 5000		2213	4554	6	26		4 44				10 48	12 26	2	6 4	72		
50	60	1 4100	7108	2150	5900	6	1	5 9					11 14	12 26		6 5	66	34	
70	50	2 3600	0060	4971		6	37	15	5 33				11 41	12 27	7	6 8	60		
60	40	2 3400	2663	2975		6	23		5 57				12 11	12 30		6 14	55	35	
40	40	1 8500	1525	4650		6	51		6 19				12 43	12 32	17	6 24	51		
30	50	1800	6163	2525		6	39		6 41				1 18	12 35		6 37	48	36	
30	40	7600	2887	0725		7	17		7 3				22 6	12 31	10	6 46	46		
		6900											23 6	12 29					
730	650	30 1900	7 0916	3 3445	4 4300	90	43	29 20	32 22	126	4	186 41	+ 36	88 22	1060				
										+ 24 0			— 9						
52	46	2 0127	4728	2389	3164	6	29	4 11	4 38	150 4		10 43	+ 9	6 19	75 78				
													— 3						
1970	1600	91 3500	19 7400	11 4107	14 3567	390	58	179 41	294 56	612 58	707 42	+ 178	390 21	4071					
													— 164						
35	27	1 5851	3463	2038	2564	6	51	6 25	10 10	10 45	12 25	+ 14	6 51	71 42					
													— 10						

Moon's last quarter (Quebec) June 1st, from 7h. 35m. a.m.

Maximum diurnal inequality in low water levels observed = 1 370 feet.

## APPENDIX 13.

TABLE XII.—Tidal Fluctuations at Pointe Platon during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.														
Gauge-book reference numbers. Series V. (raining tides.)	High and low waters observed each civil day.	Time, Eastern Standard.	Duration of floods.	Duration of ebbs.	Length of half tide day H.W. to H.W.	Priming or lagging of tides	Duration of apparent stand within 0.05 feet.	Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.		
		H. M. OF P.M.	H. M.	H. M.	H. M.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
	May 4 L.W. +	11 23 P.M.		8 33	12 50			6 6908						
•	do 3 H.W.	3 40 A.M.	4 17			55	23	14 5868	7 8960		11 2122	8 5168		
	do 5 L.W.	11 20 A.M.		7 40	12 15		29	7 2168		7 3700				
	do 3 H.W.	3 55 P.M.	4 35				29	17 0118	9 7950		11 6625	9 1613		
	do 6 L.W.	12 25 A.M.		8 30	13 10		24	6 9468		10 0650				
	do 6 H.W.	5 5 A.M.	4 40			35	24	16 3618	9 4150		11 7316	9 6355		
10	do 6 L.W.	1 3 P.M.		7 58	12 15		32	6 8808		9 4810				
	do 6 H.W.	5 20 P.M.	4 17				15	16 4518	9 5810		11 5779	9 7880		
	do 7 L.W.	1 32 A.M.		8 12	12 20		30	6 4808		9 9750				
	do 7 H.W.	5 40 A.M.	4 8			5	29	16 6018	10 1150		11 5475	10 2513		
	do 7 L.W.	1 38 P.M.		8 18	12 35		29	6 3568		10 2450				
11	do 7 H.W.	6 15 P.M.	4 17				23	17 0258	10 6700		11 8097	10 5118		
	do 8 L.W.	2 18 A.M.		8 3	12 13		12	6 7508		10 2760				
	do 8 H.W.	6 28 A.M.	4 10			19	12	17 6008	10 8560		11 9783	10 6085		
	do 8 L.W.	2 48 P.M.		8 20	12 18		12	6 5868		11 0104				
12	do 8 H.W.	6 46 P.M.	3 58				30	16 8918	10 2954		11 9992	10 6832		
	do 9 L.W.	2 33 A.M.		8 7	12 17		25	6 7168		10 1750				
	do 9 H.W.	7 3 A.M.	4 10			8	12	17 9798	11 2800		12 1437	10 8738		
	do 9 L.W.	3 27 P.M.		8 24	12 25		29	6 6968		11 2800				
13	do 9 H.W. §	7 28 P.M.	4 1				15	17 4768	10 7800		12 5193	11 1150		
	do 10 L.W.	3 25 A.M.		7 57	12 17		18	7 2268		10 2500				
	do 10 H.W.	7 45 A.M.	4 20			13	20	19 3768	12 1500		13 2630	11 2625		
	do 10 L.W.	4 2 P.M.		8 17	12 20		29	7 9168		11 4600				
14	do 10 H.W.	8 5 P.M.	4 3				20	19 1068	11 1900		13 8062	11 3538		
	do 11 L.W.	3 35 A.M.		7 50	12 0		23	8 3118		10 7950				
	do 11 H.W.	8 5 A.M.	4 10			20	20	20 4018	12 0800		13 9506	11 3475		
	do 11 L.W.	4 30 P.M.		8 25	12 30		12	8 2418		12 1600				
15	do 11 H.W.	8 35 P.M.	4 5				30	18 5868	10 3450		13 8968	11 2400		
	do 12 L.W.	4 32 A.M.		7 57	12 7		20			10 2750				
								8 3118						
Totals, 14 tides.		H.W. 90 10				55	313 245	4752						
		L.W. 60 8 48		39 11 113 58 173 2		60	327 92	3450	146 4384 144 8174 173 0385 146 3820					
		— 108 8												
Means		14 H.W.				18	22 17	3339						
	do			4 14	8 8	12 21			10 4599	10 3441	12 3599	10 4559		
	14 L.W.					15	23 7	1035						

N.B. Maxima in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °

+ Longitude Pointe Platon = 71° 51' = 4h. 47m. 24sec. = 0° 12' 56" of a day west of Greenwich.

+ Moon crosses the equator.

§ Moon in apogee, May 9th, at 8 p.m.

New moon (Quebec), May 10th, at 8.24 p.m.

## APPENDIX 13.

TABLE XII.—Tidal Fluctuations at Pointe Platon during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."									
Diurnal Inequalities.							Lunital intervals, Oscillations of float in hundredths of a foot.		Eastern standard civil times of meri- dian passages im- mediately preced- ing observed high waters, with corre- sponding ages and phases of the moon										
In duration of floods.	In duration of ebbs.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.			Upper passage.	Lower passage.	Ages, etc.	Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2)		Length of half tide day H. W. to H. W.		Priming—or lagging—of tides		Lunital intervals.	
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min	H.	M.	
											23 3								
18	53	35	2 4250	5260	4503	6445	8	1	9	7 39		3 28			+33	7 49	44		
	50	55		2700			7 53		8 2		24 3	4 9			12 41		8 7	46	
5			6500		0691	4742		8 42		8 23		4 46			12 37	+19	8 23	49	
13	32	55	1000		1537	1525						5 18			12 32		8 33	53	
	14	5		3940		0304	4633	8 35	1	8 45		25 3			12 27				
9			1400		1300			8 34			9 6		5 45		12 25	+2	8 39	57	
	6	15		4250		2622	2605								12 25				
9	15	22		3940				8 48		9 27		26 3	6 10		12 22		8 43	61	
	17	5		5800		1686	0977				9 48		6 32		12 22		8 44	65	
12			7150		0209	0757		8 40							12 20				
	13	1		1204				8 37		10 9		27 3	6 52		12 18		8 43	69	
12			1 0850		1445	1886									12 18				
	17	8		0200				8 35			10 28		7 10		12 18	—14	8 42	72	
9			5000		3756	2412									12 18				
	27	8		5300				8 38	2	10 50		28 3	7 28		12 16		8 38	75	
19			1 9000		6837	1475									12 16				
	20	3		6900				8 33	2		11 12		7 44		12 17	—17	8 32	78	
17			2700		6032	1213						29 3			12 17				
	27	20		3950				8 32	3	11 33		●			12 15		8 28	80	
			1 2950		1444	0363									12 15				
	35	30		0700				8 10	40		11 55		8 16		12 16	+19	8 21	81	
5			1 8150		0538	1075									12 16				
	28	23		0700				8 17	2	18		0 6	8 32		12 15		8 14	82	
			1 9050		2063	0275									12 15				
137	334	285	13 8050	3 8298	3 3667	3 0383	118	35	....	71	4	68 31	....	90 11	173 19	+54	118	36	912
																—58			
11	22	20	9861	2736	2405	2170	8	28	....	10	9	9 47	...	6 27	12 23	+18	8 28	65	14
																—15			

General coefficients of semi-amplitudes from "L'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.

Series V. Gaining tides.  
Gauge book reference numbers.

9

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## APPENDIX 13.

TABLE XII.—Tidal Fluctuations at Pointe Platon during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																							
Gauge book reference numbers. Series VI. Lowing tides.	High and low waters observed each civil day.	Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide day H. W. to H. W.		Priming—or lagging + of tides		Duration of apparent stand within 0.05 feet.		Elevations of summits and troughs of fluvial tide waves.		Ranges of floods.		Ranges of ebbs.		Mean tide levels corrected for diurnal inequalities.		Mean amplitudes corrected for diurnal inequalities.	
		H. M. or P. M.		H. M.		H. M.		H. M.		Min Min		Feet.		Feet.		Feet.		Feet.		Feet.		Feet.	
		H.	M.	H.	M.	H.	M.	H.	M.	Min	Min	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	
16	May 12 L. W.	4	32 A. M.							-20		8	3118										
	do 12 H. W.	8	42 A. M.	4	10					-15	22	20	4918	12	1800					14	1030	11	2125
	do 12 L. W.	5	12 P. M.			8	30	12	28		23	20	6818			11	8100						
17	do 12 H. W.	9	10 P. M.	3	58						16	19	1818	10	5850					14	5018	11	1600
	do 13 L. W.	4	59 A. M.			7	49	11	55		21	9	1618			10	1050						
	do 13 H. W.	9	5 A. M.	4	6					* 35	20	21	3018	12						14	7211	10	9484
18	do 13 L. W.	5	45 P. M.			8	40	12	20		24	9	3318										
	do 13 H. W.	9	25 P. M.	3	40						30	18	9105	9	5787					14	8632	10	7359
	do 14 L. W.	5	25 A. M.			8	0	12	8		20	9	6590			9							
19	do 14 H. W.	9	33 A. M.	4	8					-30	25	21	8025	12	1435					14	9682	10	4515
	do 14 L. W.	6	25 P. M.			8	52	12	12		28	9	8260			11	9705						
	do 14 H. W.	9	45 P. M.	3	20						25	18	2605	8	4345					10	7094	10	0988
20	do 15 L. W.	6	0 A. M.			8	15	12	20		17	9	4960			8	7645						
	do 15 H. W.	10	5 A. M.	4	5					-8	33	20	7075	11	2115					14	5018	9	8040
	do 15 L. W.	6	55 P. M.			8	50	12	22		23	9	8390			10	8685						
21	do 15 H. W.	10	27 P. M.	3	32						11	18	2105	8	3715					14	4794	9	5105
	do 16 L. W.	6	42 A. M.			8	15	12	8		22	9	6090			8	6015						
	do 16 H. W.	10	35 A. M.	3	53					+ 5	19	19	8105	10	2015					14	2166	9	3853
22	do 16 L. W.	7	37 P. M.			9	2	12	47		24	9	4390			10	3715						
	do 16 H. W.	11	22 P. M.	3	45						9	17	8055	8	3665					13	9585	9	2290
	do 17 L. W.	7	17 A. M.			7	55	12	15		17	9	2390			8	5665						
23	do 17 H. W.	11	37 A. M.	4	20					+ 13	25	18	8905	9	6515					13	5381	8	7011
	do 17 L. W.	8	25 P. M.			8	48	12	48		26	9	0700			9	8205						
	do 18 H. W.	12	25 A. M.	4	0						21	16	1000	7	0300					13	2047	8	4005
24	do 18 L. W.	8	10 A. M.			7	45	12	12		28	8	9390			7	1610						
	do 18 H. W.	12	37 P. M.	4	27					-0	12	18	5290	9	5900					13	1444	8	3505
	do 18 L. W.	9	20 P. M.			8	43	12	38		35	8	9900			9	5390						
25	do 19 H. W.	1	15 A. M.	3	55						21	16	1390	7	1490					13	1969	8	2578
	do 19 L. W.	9	15 A. M.			8	0	12	10		24	9	1460			6	9930						
	do 19 H. W.	1	25 P. M.	4	10					+ 20	20	18	4960	9	3500					13	3766	8	3373
Totals 15 tides.		137 28 + 24		59 29		117 24		172 43		+ 38		309 284 7224		145 9832		135 7990		211 5515		144 6666		3	
Means		9 27		3 58		8 23		12 20		- 88		332 138 7392		9 7322		9 6999		14 1034		9 6444			
Means		14 L. W.								+ 13		21 18 9815		9 7322		9 6999		14 1034		9 6444			

N. B.—Maxima in whole lunar month indicated by a star, thus : \* and minima by a circle, thus : °  
 † From 6.30 p.m., May 13, to 1.0 p.m., May 21, observations made with ordinary tide staffs, pending arrival of new gauge from Quebec to replace that taken by rafts, etc.

## APPENDIX 13.

TABLE XII.—Tidal Fluctuations at Pointe Platon during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."																					
Diurnal Inequalities.										Oscillations of float in hundredths of a foot.																					
					Lunital intervals.		Upper passage.			Lower passage.			Ages, etc.		Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2).			Length of half tide day H. W. to H. W.			Priming—or lagging + of tides			Lunital intervals.			General coefficients of semi-amplitudes from "l'Annuaire des Mers," corresponding to observed tides assumed to be 48 hours old.				
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	Days.	H.	M.	H.	M.	H.	M.	Min	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
21	1 2250	3700	3987	0525	8	2	40	1 6	8	47	12 16	19	8	7	82																
23	2 0350	4800	2193	2116	8	7	1 3	9	3	12 15	19	8	0	82																	
25	2 3913	1700	1421	2125	7	38	1 27	2 6	9	18	12 16	19	7	51	81																
12	2 8920	3272	1050	2844	7	34	1 51	2 6	9	34	12 16	18	7	43	80																
4	*3 5420	1670	2588	3547	7	17	2 16	3 6	9	50	12 16	18	7	34	78																
8	2 4470	3300	1399	2928	7	4	2 41	10	6	12 16	7	25	76																		
2	2 3430	3430	0901	2932	6	59	3 6	10	22	12 18	16	7	16	73																	
14	1 6000	2300	2628	1255	6	56	3 31	10	40	12 18	7	9	70																		
39	1700	1700	2581	1463	6	38	3 57	10	58	12 19	13	7	1	66																	
32	2 0050	2000	2581	1463	7	0	4 22	5 6	11	17	12 19	6	55	62																	
33	1 0850	1690	4204	4719	6	49	4 48	11	39	12 22	4	6	51	58																	
26	2 7905	1310	3334	3667	7	11	5 14	12	3	12 24	6	49	54																		
25	2 4290	0510	0603	0406	6	58	5 39	12	29	12 26	+ 6	6	50	51																	
28	2 3900	1560	0525	1020	7	11	6 4	7 6	59	12 30	6	55	48																		
20	2 3570	1797	0795	6 55	6	55	6 30	1	33	12 34	+ 22	7	3	46																	
33	2 6858	3 2942	2 9211	3 0342	108	19	24	46	40	23	+ 84	124	23	162	38	38	172	46	+ 28	109	29	1007									
24	2 2633	2353	2087	2171	7	13	3 32	15	33	10	51	12	20	7	18	67	13	15													

Maximum diurnal inequality in high water levels according to observations with plain tide staff (not accurate).

h. Moon's north declination a maximum =  $21^{\circ} 8'$ .  
Moon's first quarter (Quebec), May 18th, from 6h. 5m. p.m.

8<sup>th</sup>—20<sup>th</sup>

## APPENDIX 13.

TABLE XII.—Tidal Fluctuations at Pointe Platon during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																			
Gauge book reference numbers. Series VII. Gaining tides.	High and low waters observed each civil day.	Time, Eastern Standard.	Duration of floods.		Duration of ebbs.		Length of half tide-day H. W. to H. W.	Priming or lagging + of tides.		Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	Duration of floods.				
			H.	M.	A. M. or P. M.	H.		M.	H.							M.	Min	Min	Feet.
	May 18th w	1 25 P. M.																	
23	do 19 L. W.	10 20 P. M.				8 55	13 0						9 2260						
	do 20 H. W.	2 25 A. M.	4 5			8 12	12 30					7 7800	8 2110	13 2631	8 4170				
24	do 20 L. W.	10 37 A. M.				8 12	12 30						8 2110	12 3511	8 3630				
	do 20 H. W.	2 53 P. M.	4 18			8 37	12 50					8 4510	8 8300						
25	do 21 L. W.	11 32 P. M.				8 37	12 50						8 8300						
	do 21 H. W.	3 45 A. M.	4 13			8 10	12 30					8 7600	8 5810	13 0312	8 9634				
26	do 21 L. W.	11 55 A. M.				8 10	12 30						8 5810						
	do 21 H. W.	4 5 P. M.	4 10			8 34	12 38					9 6824	13 5555	9 5161					
27	do 22 L. W.	12 39 A. M.				8 34	12 38						9 7654						
	do 22 H. W.	4 43 A. M.	4 4			8 32	12 29					10 0364	13 5276	9 987					
28	do 22 L. W.	1 15 P. M.				8 32	12 29						10 0750						
	do 22 H. W.	5 12 P. M.	3 57			8 18	12 21					10 0650	13 7245	10 4663					
29	do 23 L. W.	1 30 A. M.				8 18	12 21						10 1050						
	do 23 H. W.	5 33 A. M.	4 3			8 40	12 33					11 6300	14 0665	11 0430					
30	do 23 L. W.	2 13 P. M.				8 40	12 33						11 4950						
	do 23 H. W.	6 6 P. M.	3 53			8 18	12 17					10 9500	14 4063	11 4408					
31	do 24 L. W.	2 24 A. M.				8 18	12 17						10 7850						
	do 24 H. W.	6 23 A. M.	3 59			8 45	12 34					12 5650	14 8010	11 8243					
32	do 24 L. W.	3 8 P. M.				8 45	12 34						12 3200						
	do 24 H. W.	6 57 P. M.	3 49			8 18	12 16					11 6270	15 1355	12 1690					
33	do 25 L. W.	3 15 A. M.				8 18	12 16						11 5400						
	do 25 H. W.	7 13 A. M.	3 58			8 49	12 40					13 1810	15 3937	12 5865					
34	do 25 L. W.	4 2 P. M.				8 49	12 40						12 9610						
	do 25 H. W.	7 53 P. M.	3 51			8 11	12 11					11 8560	15 5357	12 5545					
35	do 26 L. W.	4 4 A. M.				8 11	12 11						11 9600						
	do 26 H. W.	8 4 A. M.	4 0									13 4410	15 5656	12 5683					
	do 26 L. W.	4 55 P. M.				8 51	12 34						13 2910						
	do 26 H. W.	8 38 P. M.	3 43									11 5810	15 5925	12 6009					
Totals 14 tides			79 52			56 3	119 10	175 13											
Means			83 49	48															
14 H. W.			131 49																
14 L. W.						4 0	8 31	12 31				10 8282	10 6538	14 3067	10 4034				

N.B.—Maximum whole lunar month indicated by a star, thus \*; and minima by a circle, thus °.  
 \* From 6h. 30m. p.m., May 13th, to 1h. a.m., May 21st—observations made with ordinary tide-gauges pending arrival of new ones gauge ordered from Quebec to replace that broken by raft and steamboat.

## APPENDIX 13.

TABLE XII.—Tidal Fluctuations at Pointe Platon during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."													
Diurnal Inequalities.						Lunital intervals.		Oscillations of float in hundredths of a foot.		Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)		Length of half tide day H. W. to H. W.		Priming—or lagging + of tides		Lunital intervals		General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.		Series VII. Gaining tides. Gauge book reference numbers.
In elevation of ebb.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.					Upper passage.	Lower passage.	Ages, etc.											
Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	H.	M.	Min	H.	M.				
43	30	1 4460	1240														+22						
43	30		2400	4310	1135	7	30	6	55						12	38		7	16			46	23
43	30																						
43	30		0700	3790	3320	1460	7	34		9	6				12	40		7	30			48	23
43	30																+29						
43	30		1 1014	1790	1001	4004	7	59	7	46					12	39		7	44			51	23
43	30																						
43	30		2700	0830	3243	5527	7	53		8	12				12	37		7	55			56	23
43	30																+21						
43	30		0200	0396	1721	4666	8	5	8	38					12	34		8	3			62	23
43	30																						
43	30		1 5250	0500	1969	4836	8	7		9	5				12	31		8	7			69	23
43	30																+9						
43	30		5450	1350	3320	5787	8	1		9	32				12	28		8	8			76	23
43	30																						
43	30		1 7800	1650	3518	4038	8	7		9	59				12	26		8	7			83	23
43	30																+1						
43	30		6930	2450	3927	3755	7	56	10	27					12	25		8	4			89	23
43	30																						
43	30		1 6330	0790	3345	3447	8	1		10	56				12	24		7	59			95	23
43	30																+2						
43	30		1 1050	2200	2582	2175	7	47	1	11	26				12	24		7	53			100	23
43	30																						
43	30		1 4810	1040	1420	1680	7	58	1		11	55			12	24		7	48			104	23
43	30																						
43	30		1 7100	1500	0299	0138	7	38	8		26				12	23		7	40			106	23
43	30																						
43	30		0269	0337			3				15	6			12	23		7	33			*107	23
43	30																+3						
382	27	13 6194	2 3836	3 1069	4 2647	110	18	67	10	70	24				79	21	174	56	+60	109	47	1092	
															-168	0			-8				
															-247	21							
27	19	9728	1703	2219	3046	7	53	9	36	10	3				17	40	12	30	+15	7	51	78	00
																			-3				

: Moon after crossing equator.

§ Moon in perigee, May 24th, at 2h. 0m. p.m.

Full moon (Quebec), May 25th, at 8h. 40m. a.m.

## APPENDIX 13.

TABLE XII.—Tidal Fluctuations at Pointe Platon during the High water season of 1888, viz., from quadrature May 2nd, to quadrature June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																				
Gauge book reference numbers. Series VIII. Lowing tides.	High and low waters observed each civil day.	Time, Eastern Standard.	Duration of floods.		Duration of ebbs.	Length of half tide day H. W. to H. W.		Priming or lagging + of tides.		Duration of apparent stand within 0.05 feet.	Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.		Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	In duration of floods.	In duration of ebbs.		
			A. M.			H. M.		H. M.				Min.							Feet.	
			H.	M.		H.	M.	H.	M.			Min.	Min.						Feet.	Feet.
	May 26 H. W.	8 38 P. M.	3 43						1		20 93.4									
30	do 27 L. W.	4 49 A. M.			8 11	12 17				18	9 2264		11 7110				23	3		
	do 27 H. W.	8 55 A. M.	4 6							25	23 0514	13 9250	15 6060	12 5190			12	3		
	do 27 L. W.	5 45 P. M.			8 50	12 38				22	9 4064		13 5850				12	3		
31	do 27 H. W. †	9 33 P. M.	3 48						2		13 20 4214	10 9550	15 4539	12 2948			12	3		
	do 28 L. W.	5 33 A. M.			8 0	12 10				15	9 1464		11 3750				12	3		
	do 28 H. W.	9 43 A. M.	4 10							11	22 5107	13 3643	15 1838	12 1147			12	3		
32	do 28 L. W.	6 37 P. M.			8 54	12 37				16	9 1064		13 4043				12	3		
	do 28 H. W.	10 20 P. M.	3 43						5		21 19 3214	10 4150	14 9107	11 8386			12	3		
	do 29 L. W.	6 27 A. M.			8 7	12 8				11	8 8764		10 6450				12	3		
33	do 29 H. W.	10 28 A. M.	4 1							18	21 7664	12 8900	14 6502	11 6575			12	3		
	do 29 L. W.	7 29 P. M.			9 1	12 45				19	8 7664		13 0000				12	3		
	do 29 H. W.	11 13 P. M.	3 44						3		33 18 8614	10 0860	14 3452	11 3035			12	3		
34	do 30 L. W.	7 12 A. M.			7 50	12 2				21	8 6204		10 2410				12	3		
	do 30 H. W.	11 15 A. M.	4 3							20	20 494	11 8780	13 9029	10 9990			12	3		
	do 30 L. W.	8 18 P. M.			9 3	12 55				24	8 1864		12 3120				12	3		
35	do 31 H. W.	12 10 A. M.	3 52						7		21 17 7514	9 5650	13 5486	10 6143			12	3		
	do 31 L. W.	8 5 A. M.			7 55	12 2				23	8 2964		9 4550				12	3		
	do 31 H. W.	12 12 P. M.	4 7							19	19 4214	11 1250	13 3065	10 2913			12	3		
36	do 31 L. W.	9 3 P. M.			8 51	12 53				25	8 0314		11 3900				12	3		
	June 1 H. W.	1 5 A. M.	4 2						15		16 17 2264	9 1950	13 2914	10 0800			12	3		
	do 1 L. W. ‡	8 53 A. M.			7 48	12 12				22	8 3214		8 7050				12	3		
37	do 1 H. W.	1 17 P. M.	4 24							28	19 3514	10 8300	13 3890	9 8550			12	3		
	do 1 L. W.	10 0 P. M.			8 43	12 47				17	8 4014		10 9500				12	3		
	do 2 H. W.	2 4 A. M.	4 4						8		25 17 3364	8 9350	13 1027	9 4575			12	3		
38	do 2 L. W.	10 8 A. M.			8 4	12 11				25	8 3664		8 9700				12	3		
	do 2 H. W.	2 15 P. M.	4 7							21	17 2614	8 8950	12 4658	9 1938			12	3		
	do 2 L. W.	10 54 P. M.			8 39	12 58				24	7 3714		9 8900				12	3		
39	do 3 H. W.	3 13 A. M.	4 19						24		23 16 3914	9 0200	12 1650	9 2530			12	3		
	do 3 L. W.	11 13 A. M.			8 0	12 16				23	7 7064						12	3		
	H. W. 105 43	24							54		24 271	3709					12	3		
Totals 14 tides			129 43		56 30	126	5 186 51						150 9873 155 5333 195 3247 151 4020 232 725							
L. W. 120 26									10		305 120 3836									
14 H. W.									14		21 19 3836									
Means do					4 2	8 24	12 27					10 7848	11 1085	13 9518	10 8144	17 32				
15 L. W.									3		20 8 5988									
H. W.											187 1219 1077 2529									
Grand totals 57 tides					39 13	476 37 707 49						586 0037 585 3031 740 2265 594 9575 860 2171								
L. W.											158 1273 475 5084									
57 H. W.									13		21 18 8991									
Grand means do					4 4	8 22	12 25					10 4387	10 4518	13 6884	10 4378	16 37				
57 L. W.									8		22 8 3431									

N. B. — Maxima in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °

† Moon's S. declination a maximum - 21° 41'.

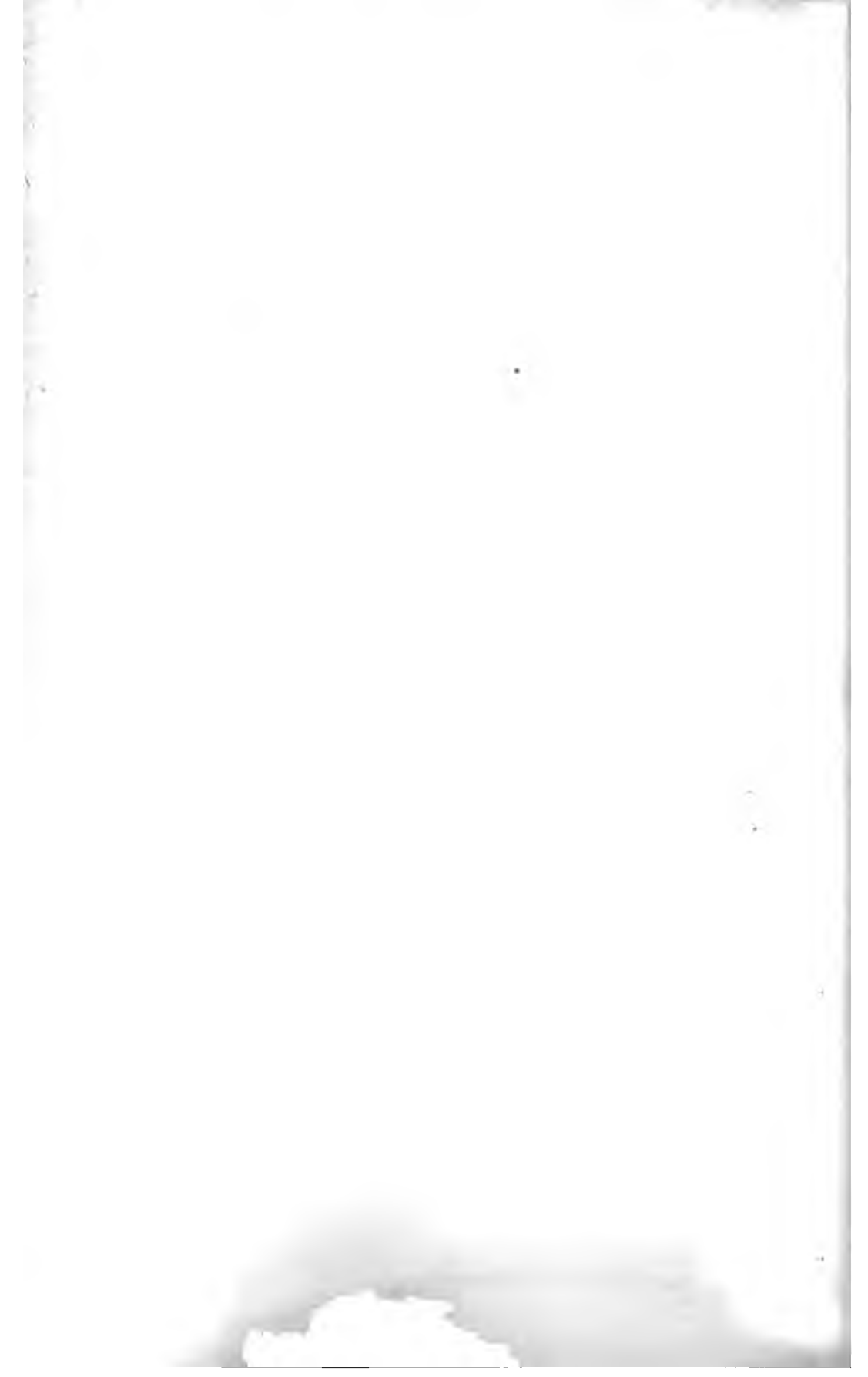
‡ Maximum diurnal inequality in high water levels observed with box gauge = 2.900 ft.

## APPENDIX 13.

TABLE XII.—Tide Fluctuations at Pointe Platon during the High water season of 1888, viz., from quadrature May 2nd, to quadrature June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).						RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."												Series VIII. Losing tides. Gauge book reference numbers.			
Diurnal Inequalities.					Lunital intervals.	Oscillations of float in hundredths of a foot.	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.					Eastern standard civil times of high water at Quebec, based on Brest times. (No. 2).					Length of half-tide day H. W. to H. W.		Priming—or lagging + of tides	Lunital intervals.	General coefficients of semi-amplitudes from "L'Annuaire des Mares," corresponding to observed tides assumed to be 48 hours old.
In semi-tide days.	In high waters.	In low water levels.	In mean tide level.	In amplitudes.			Upper passage.	Lower passage.	Ages, etc.	H.	M.	H.	M.	Days.	H.	M.					
Min	Feet.	Feet.	Feet.	Feet.	H.	M.															
		1300															3				
21	2 1140		0135	0830		1									12 24						
28	2 6300		1521	2242	7 28	20	1	27				1 66		8 53	12 23		7 26	106	30		
27	2 0893		2701	1801	7 35	3			1	58				9 16	12 24	3	7 18	104			
29	2 9893		2731	2761	7 15	5	2	28				17 6		9 40	12 24		7 12	101	31		
37	2 2450		2605	1811	7 23	1			2	57				10 4	12 23	3	7 7	96			
43	2 9050		3050	3540	7 2		3	26				18 6		10 27	12 23		7 1	91	32		
53	1 6370		4423	3045	7 20				3	53				10 50	12 24	3	6 57	85			
53	2 7470		3543	3847	6 55		4	20				19 6		11 14	12 26		6 54	79	33		
51	1 6700		2391	3230	7 24				4	46				11 40	12 26	2	6 54	72			
41	2 1950		0181	2613	7 1		5	11				20 6		12 6	12 27		6 55	66	34		
35	2 1250		0976	1750	7 30	3			5	35				12 33	12 30	7	6 58	60			
36	2 0150		2863	4175	7 19	3	5	58				21 6		1 3	12 32		7 5	55	35		
47	0 750		6369	2437	7 43				6	21				1 35	12 35	17	7 14	51			
42	8700		3008	0592	7 32		6	43				22 6		2 10	12 31		7 27	48	36		
	7300				8 9				7	4				2 41	12 29	10	7 37	46			
												23 6									
543 29	0366	3 9990	3 6497	3 4674	103 36	...	29	33	32	34	...	114 12	186 41	+ 36		100 5	1060				
												+ 48 0		— 9							
												162 12		+ 9							
39 1	9358	2666	2606	2477	7 24	...	4	13	4	39	...	11 35	12 27	— 3		7 9	75 71				
1462 88	1468	13 5066	13 0444	13 8046	440 48	...	192	33	211	52	...	662 22	707 42	+ 178		437 57	4071				
															— 164						
															+ 14						
26 1	5464	2370	2329	2465	7 52	...	6	53	7	19	...	11 37	12 25	— 10		7 41	71 42				

\* § Moon's last quarter (Quebec) June 1st from 7h. 53m. p.m.  
Maximum diurnal inequality observed in low water levels = 0.995 feet.



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## APPENDIX 13.

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TIDAL FLUCTUATIONS, ETC.,

GRONDINES, ST. JEAN DES CHAILLONS AND BATISCAN,

DURING A COMPLETE LUNAR MONTH OF THE HIGH WATER SEASON  
OF 1888, VIZ., MAY 2, TO JUNE 1.

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TABLES XIII, XIV AND XV.

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WEEKLY SERIES OF GAINING AND LOSING  
TIDES Nos. V, VI, VII AND VIII.

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## APPENDIX 13.

TABLE XIII.—Tidal Fluctuations at Grandines during the High water season of 1887.  
viz. :—from quadrature, May 2nd, to quadrature, June 1st.

## DIRECT RESULTS OF TIDAL OBSERVATIONS, &amp;c.

Gauge bank reference numbers. Series V. Gauging tides.	High and low waters observed each civil day.	Time, Eastern Standard.	Duration of floods.		Duration of ebbs.		Length of half tide day H. W. to H. W.		Priming—or lagging—of tides		Duration of apparent stand within 0.06 feet.		Elevations of summits and troughs of fluvial tide waves.		Ranges of floods.		Ranges of ebbs.		Mean tide levels corrected for diurnal inequalities.		Mean amplitudes corrected for diurnal inequalities.		In duration of floods.		In duration of ebbs.	
			H. M.		H. M.		H. M.		H. M.		Min Min		Feet.		Feet.		Feet.		Feet.		Feet.		Min.		M.	
			A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
	May 5 L.W.	12 53 A.M.					9 10	12 59					13 3474													
10	do 5 H.W.	4 42 A.M.	3 49						22	36	17 1974	3 8500			15 4950	4 3350										
	do 5 L.W.	1 0 P.M.			8 18	12 13				45	13 3074			3 8900									6			
	do 5 H.W.	4 55 P.M.	3 55					9 0	12 47		36	18 2074	4 9000		15 5812	4 5075										
	do 6 L.W.	1 55 A.M.			9 0	12 47				47	13 3474		4 8600									8				
11	do 6 H.W.	5 42 A.M.	3 47						15	54	17 7274	4 3800		15 5912	4 5175											
	do 6 L.W.	2 20 P.M.			8 38	12 18				46	13 3174		4 4100													
	do 6 H.W.	6 0 P.M.	3 40							34	17 7374	4 4200		15 4800	4 5600											
	do 7 L.W.	2 50 A.M.			8 50	12 38				47	13 0574		4 6800													
12	do 7 H.W.	6 38 A.M.	3 48						12	30	17 8074	4 7500		15 4575	4 8400											
	do 7 L.W.	3 20 P.M.			8 42	12 24				41	13 0174		4 7900													
	do 7 H.W.	7 2 P.M.	3 42							31	18 1574	5 1400		15 6887	5 0225											
	do 8 L.W.	3 32 A.M.			8 30	12 14				49	13 3374		4 8200													
13	do 8 H.W.	7 16 A.M.	3 44						0	21	18 6774	5 3400		15 9012	5 0275											
	do 8 L.W.	4 3 P.M.			8 47	12 26				41	13 4374		5 2400													
	do 8 H.W.	7 42 P.M.	3 30							31	18 1474	4 7100		16 0000	5 0150											
	do 9 L.W.	4 8 A.M.			8 26	12 5				40	13 5474		4 6000													
14	do 9 H.W.	7 47 A.M.	3 39						22	28	19 0574	5 5100		16 1725	5 1200											
	do 9 L.W.	4 40 P.M.			8 53	12 23				38	13 6774		5 3800													
	do 9 H.W.	8 10 P.M.	3 30							29	18 6674	4 9900		16 4722	5 3085											
	do 10 L.W.	4 31 A.M.			8 21	12 1				37	13 9574		4 7100													
15	do 10 H.W.	8 11 A.M.	3 40						13	33	20 1154	6 1580		16 9670	5 6190											
	do 10 L.W.	5 1 P.M.			8 56	12 36				39	14 3574		5 7580													
	do 10 H.W.	8 47 P.M.	3 46							30	20 2074	5 8500		17 4844	5 9038											
	do 11 L.W.	4 57 A.M.			8 10	11 49				35	14 7074		5 5000													
16	do 11 H.W.	8 36 A.M.	3 39						20	29	21 2144	6 5070		17 7279	5 8310											
	do 11 L.W.	5 42 P.M.			9 6	12 41				35	14 9174		6 2970													
	do 11 H.W.	9 17 P.M.	3 35							28	19 9374	5 0200		17 7327	5 6205											
	do 12 L.W.	5 27 A.M.			8 10	11 50				33			4 9500													
		H.W. 100 45							49	430 262 8586																
Totals 14 tides.		53 26	24 51	53 120 41 172 25					55	620 191 3336			71 5250 69 4850 227 6015 71 3338 83 65													
		L.W. 77 26																								
Means		14 H.W.							16	81 18 7756			5 1089	4 9918	16 2715	5 6224	6 30									
		do																								
		14 L.W.							13	41 13 6667																

N.B. Maxima in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °

Longitude Grandines wharf 72° 2' 4h. 48m. 8s. = 0.2001 of a day west of Greenwich.

Moon crosses the equator.

Moon in apogee, May 9th, at 8 p.m.

New moon (Quebec) May 10th, at 8h. 24m. p.m.

## APPENDIX 13.

TABLE XIII.—Tidal Fluctuations at Grondines during the High water season of 1887, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued.)							RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."														
Diurnal Inequalities.					Lunital intervals.		Oscillations of float in hundredths of a foot.	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.					Eastern standard civil times of high water at Quebec, based on Brest times. (No. 2)	Length of half tide day H. W. to H. W.	Priming—or lagging + of tides	Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.	Series V. Gaining tides.	Gauge book reference numbers.	
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.				Upper passage.	Lower passage.	Ages, etc.	Days.										
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.					
									23.3			12.42									
46		0400			9	2		7	40		4	12		+ 33	8	32		44			
1	0100		0862	1725																	
34		0400			8	53		8	2		24.3	4	53			8	51		46		
	4800		0100	0100									12.37								
29		0300			9	18			8	24		5	30		+ 19	9	6		49		
	0100		1212	0475									12.32								
20		2600			9	15		8	45		25.3	6	2			9	17		53		
	0700		0125	2750									12.27								
14		0400			9	31			9	7		6	29		+ 2	9	22		57		
	3500		2312	1825									12.25								
10		3200			* 9	34		9	28		26.3	6	54			9	26		61		
	5200		2125	0050									12.22								
12		1000			9	28			9	48		7	16			8	28		65		
	5300		0988	0125									12.20								
21		1100			9	33		10	9		27.3	7	36			9	27		69		
	9100		1725	1050									12.18								
18		1300			9	17			10	30		7	54		— 14	9	24		72		
	3900		2997	1895									12.18								
22		2800			9	19		10	51		28.3	8	12			9	21		75		
1	4480		4948	3095									12.16								
35		4000			8	58			11	13		8	28		— 17	9	15		78		
	0920		* 5174	2848			3			●			12.17								
47		3500			9	13	3	11	34		29.3	8	45			9	11		80		
	1 0070		2435	0728			2						12.15								
32		2100			8	40	2				11	56		9	0		— 19	9	4	81	
	1 2770		0648	1505			3						12.16								
51		0700			8	59	5	0	18		0	6	9	16			8	58	82		
	1 5050		2195	0310			3						12.15								
411	9 5990	2 3800	2 7846	1 8481	129	0	....		71	7	68	38	....	100	27	173	19	+ 54			
																	— 58				
29	6856	1700	1989	1320	9	13	....		10	9	9	48	...	7	11	12	23	+ 18			
																	— 15				

## APPENDIX 13.

TABLE XIII.—Tidal Fluctuations at Grondines during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

# DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.

Change back reference numbers, Series VI, falling tide.

16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31

High and low waters observed each civil day.		Time, Eastern Standard.	Duration of floods.		Duration of ebb.		Length of half tide day H. W. to H. W.		Priming or lagging + of tides.		Elevation of summits and troughs of fluvial tide waves.	Ranges of floods.		Ranges of ebb.		Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.		In direction of floods.
			H.	M.	H.	M.	H.	M.	Min.	Min.		Feet.	Feet.	Feet.	Feet.		Feet.	Feet.	
May	12 L. W.	5:27 A. M.							20		14 9674								
do	12 H. W.	9:17 A. M.	8:40						35		21 4234	6 4550				18 0122	5 6195		
do	12 L. W.	6:12 P. M.			9:15	12:35					15 3674		6 0550			18 4117	5 3484		16
do	12 H. W.	9:42 P. M.	8:30								15 3674	5 1230				18 4117	5 3484		
do	12 L. W.	5:58 A. M.			8:16	11:55					15 3674		4 6330			18 7513	5 2478		9
do	12 H. W.	9:37 A. M.	8:59						15		15 3674	6 3626				18 7513	5 2478		
do	12 L. W.	6:49 P. M.			9:12	12:40					16 3674		5 8836			18 9739	5 0338		11
do	12 H. W.	10:17 P. M.	8:28								16 3674	4 1000				18 9739	5 0338		
do	12 L. W.	6:19 A. M.			8:2	11:55					16 3674		3 3200			19 1566	4 943		25
do	12 H. W.	10:12 A. M.	8:53						9		16 3674	6 2136				19 1566	4 943		
do	12 L. W.	7:24 P. M.			9:12	12:46					16 3674		5 9426			19 1728	4 5907		19
do	12 H. W.	10:58 P. M.	8:34								16 3674	8 7100				19 1728	4 5907		
do	12 L. W.	7:5 A. M.			8:7	11:48					16 3674		3 3900			19 1728	4 5907		
do	12 H. W.	10:46 A. M.	8:41						14		16 3674	5 1300				19 1672	4 1803		
do	12 L. W.	8:5 P. M.			9:19	12:48					17 3674		4 7000			19 1672	4 1803		12
do	12 H. W.	11:34 P. M.	8:39								16 3674	8 1300				19 1476	3 9378		
do	12 L. W.	7:50 A. M.			8:16	11:54					17 1474		3 1500			19 0147	3 6945		9
do	12 H. W.	11:29 A. M.	8:38						8		17 3624	4 4550				19 0147	3 6945		
do	12 L. W.	8:57 P. M.			9:29	12:53					17 1874		4 4130			18 8144	3 4738		14
do	12 H. W.	12:21 A. M.	8:24								19 3674	2 6300				18 8144	3 4738		
do	12 L. W.	8:32 A. M.			8:11	12:1					16 3674		2 7700			18 3682	3 2475		36
do	12 H. W.	12:32 P. M.	8:50						17		16 3674	8 3000				18 3682	3 2475		
do	12 L. W.	9:47 P. M.			9:25	13:6					16 3674		8 3700			18 4112	3 675		9
do	12 H. W.	1:29 A. M.	8:41								16 3674	8 1300				18 4112	3 675		
do	12 L. W.	9:33 A. M.			8:4	11:54					16 3674		8 3000			18 3300	3 6750		
do	12 H. W.	1:23 P. M.	8:50						7		16 3674	8 7800				18 3300	3 6750		
do	12 L. W.	10:42 A. M.			9:20	13:3					16 3674		8 7800			18 3300	3 6750		
do	12 H. W.	2:25 P. M.	8:48								16 3674	2 8700				18 3300	3 6750		
do	12 L. W.	10:25 A. M.			8:0	12:2					16 3674		2 8700			18 3300	3 6750		19
do	12 H. W.	2:27 P. M.	8:42						10		16 3674	8 3700				18 3300	3 6750		

Totals 13 tides		H. W.	126:6	24					24	531.312	2612			51 0822	15 3382	230 0000	41 9634	16
		L. W.	118:87		55	2 121	7 13	20										
Means		H. W.			8:40		7:48	12:28				4 9446	4 1428	17 7131	4 1271	13		
		L. W.					15	49	16 3794									

N.B. Maximum whole lunar month index is 10 + 5, thus 10 + 5 = 15, and minimum is 0, thus 0 + 5 = 5.

## APPENDIX 13.

TABLE XIII.—Tidal Fluctuations at Grondines during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).							RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."																		
Diurnal Inequalities.						Lunital intervals.		Oscillation of float in hundredths of a foot	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times (No. 2).			Length of half tide day H. W. to H. W.		Priming—or lagging + of tides		Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.	Series VL Gaining tides. Gauge book reference numbers.			
In duration of ebb.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.				Upper passage.	Lower passage.	Ages, etc.	H.	M.	Days.	H.	M.	H.	M.					Min.	H.	M.
						H.	M.																		
55	45	9170	4000	3995	3011	8	26	5			41			9	31			19							
49	40	1 7246	5000	3396	1006	8	38	3	1	4		1	6		9	47		12	15		8	50	82	16	
56	45	1 7746	4800		2226	8	9	1				1	28		1	02		19			8	34	81		
70	45	2 2846	1800	1827	0845	8	25		1	52				10	18						8	26	80	17	
70	51	2 2326	2700		0162	7	55	2				2	17		10	34		18			8	17	78		
55	58	1 5300	1200		0056	8	17	3	2	41				10	50						8	9	76	18	
72	60	1 6520	2700		0196	7	39					3	7		11	6		16			7	59	73		
63	54	1 1970	0600	1329	2433	8	2		3	32				11	24						7	52	70	19	
73	59	1 7650	0400	2003	2207	7	30					3	58		11	42		13			7	44	66		
78	52	1 0900	2200	2282	2263	7	58		4	23				12	1						7	38	62	20	
74	65	1 7800	0100		1750	7	33					4	49		12	23		4			7	34	58		
81	72	1 4300	1700	0812	0025	8	14		5	14				12	47						7	33	54	21	
76	69	1 4100	0100	0075	0650	7	42					5	40		1	13		6			7	33	51		
80	61	1 4900	0900		1012	8	20		6	5				1	43						7	38	48	22	
80	56				1125	7	56	3				6	31	8	6		2	17			+	22	7	46	46
1032	832	22 2774	2 8200	2 1121	2 7520	120	44		24	51		40	31		137	38	172	46		+	28	120	16	1007	
												+	84	0		+	36	0		—	89				
												—	124	31		—	173	38							
69	55	1 5912	2014	1509	1966	8	3		3	33		15	34		11	35	12	20			8	1	67	13	
																					+	14			
																					—	15			

†Maximum diurnal inequality in high water levels observed = 0.500.

‡ Moon's N. declination a maximum =  $21^{\circ}8'$ . § Moon's first quarter (Quebec) May 18th, from 6-5 p.m.

## APPENDIX 13.

TABLE XIII.—Tidal Fluctuations at Grondines during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																		
Gauge mark reference numbers. Series VII. (gaining tides.)	High and low waters observed each civil day.	Time, Eastern Standard.	Duration of floods.			Duration of ebbs.			Length of half tide day H. W. to H. W.	Priming - or lagging + of tides		Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	In duration of floods.	
			A. M. or P. M.			H. M. or P. M.				Duration of apparent stand within 0.05 feet.								
			H.	M.	P. M.	H.	M.	P. M.		Min	Min							Feet.
	May 19 H. W.	2 27 P. M.								- 10		20 6574						
23	May 19 L. W.	11 47 P. M.				9 20	12 58				39	16 8874		3 7700		3 3050	24	
	do 20 H. W.	3 25 A. M.	3 38								40	19 7174	2 8300	18 3600		3 2073	5	
	do 20 L. W.	12 12 P. M.				8 47	12 30				57	16 6274		3 0900		3 2073	5	
	do 20 H. W.	3 55 P. M.	3 43							- 21	32	19 7574	3 1300	18 1412		3 4345	4	
24	do 21 L. W.	12 57 A. M.				9 2	12 41				60	16 4474		3 3100		3 4345	4	
	do 21 H. W.	4 36 A. M.	3 39								32	19 7474	3 3000	18 1597		3 7485	4	
	do 21 L. W.	1 12 P. M.				8 36	12 19				56	16 4374		3 3100		3 7485	4	
	do 21 H. W.	4 55 P. M.	3 43							- 7	40	20 2554	3 8180	18 2867		3 9790	7	
25	do 22 L. W. †	1 57 A. M.				9 2	12 38				54	16 3874		3 8680		3 9790	7	
	do 22 H. W.	5 33 A. M.	3 36								31	20 3854	3 9980	18 3565		4 3098	4	
	do 22 L. W.	2 30 P. M.				8 57	12 29				52	16 3474		4 0380		4 3098	4	
	do 22 H. W.	6 2 P. M.	3 32							- 5	33	20 3554	4 0080	18 4773		4 7313	1	
26	do 23 L. W.	2 45 A. M.				8 43	12 16				41	16 2974		4 0580		4 7313	1	
	do 23 H. W.	6 18 A. M.	3 33								28	21 4324	5 1350	18 6930		5 0823	8	
	do 23 L. W.	3 27 P. M.				9 9	12 34				41	16 3574		5 0750		5 0823	8	
	do 23 H. W.	6 32 P. M.	3 25							- 20	28	21 0144	4 6570	18 8935		5 4080	10	
27	do 24 L. W.	3 33 A. M.				8 41	12 16				39	16 3474		4 6670		5 4080	10	
	do 24 H. W.	7 8 A. M.	3 35								32	22 2774	5 9300	19 1515		5 7600	12	
	do 24 L. W. †	4 15 P. M.				9 7	12 30				39	16 5474		5 7300		5 7600	12	
	do 24 H. W.	7 38 P. M.	3 23							16	27	21 8524	5 3650	19 4124		6 0388	2	
28	do 25 L. W.	4 17 A. M.				8 39	12 4				36	16 5174		5 3350		6 0388	2	
	do 25 H. W. ‡	7 42 A. M.	3 25								23	23 1874	6 6700	19 6119		6 2300	10	
	do 25 L. W.	5 7 P. M.				9 25	12 40				35	16 6674		6 5280		6 2300	10	
	do 25 H. W.	8 22 P. M.	3 15							5	18	22 2974	5 6300	19 7075		6 2800	4	
29	do 26 L. W.	5 8 A. M.				8 46	12 5				32	16 5174		5 7800		6 2800	4	
	do 26 H. W.	8 27 A. M.	3 19								20	23 5074	6 9900	19 7275		6 3250	6	
	do 26 L. W.	6 0 P. M.				9 33	12 46				35	16 6574		6 8580		6 3250	6	
	do 26 H. W.	9 13 P. M.	3 13							5	21	22 1574	5 5900	* 20 8256				
Totals 14 tides			H. W.	90	6					- 22	417	297	9446	66 9070	65 4010	265 0043	67 7385	101
			L. W.	77	7	24				81	636	231	0436					
				101	7													
Means			14 H. W.			3 30	8 59	12 29		9	30	21	2818	4 7787	4 6715	18 3238	4 8385	7
			do							8	45	16	5031					
			14 L. W.															

N. B. Maxima in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °

† Moon after crossing the equator.

‡ Moon in perigee, May 24th, at 2 0 p.m.

§ Full moon (Quebec), May 25th, at 8 40 a.m.

## APPENDIX 13.

TABLE XIII.—Tidal Fluctuations at Grondines during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).							RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."											Series VII. Gaining tides. Gauge book reference numbers.	
Diurnal Inequalities.						RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."													
In duration of ebb.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.	Lunital intervals.	RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."												
Min.	Min.	Feet.	Feet.	Feet.	Feet.	H. M.	Oscillations of float in hundredths of a foot.	Upper passage.	Lower passage.	Ages, etc.	Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)	Length of half tide day H.W. to H.W.	Priming—or lagging—of tides	Lunital intervals.	General coefficients of semi-amplitudes from "l'Annuaire des Mares," corresponding to observed tides assumed to be 48 hours old.				
								H. M.	H. M.	Days.	H. M.	H. M.	Min	H. M.					
			1800										+22						
33	28	9400	2600	0637	0475	8 29		6 56			2 55	12 38		7 59	46	23			
15	11	0400	1800	2188	0023	8 34			7 21	9 6	3 35	12 40	+29	8 14	48				
26	22	0100	0100	0185	2272	8 49		7 47			4 14	12 39		8 27	51	24			
26	19	5080		1270	3140	8 42			8 13	10 6	4 51	12 37	+21	8 38	56				
5	29	1300	0500	0698	2295	8 54		8 39			5 25	12 34		8 46	62	25			
14	13	0300	0400	1208	3318	8 57				11 6	5 36	12 31	+9	8 51	69				
26	18	1 0770	0600	2157	4215	8 46		9 32			6 24	12 28		8 52	76	26			
28	18	4180	0100	2005	3510	8 52			10 0	12 6	6 50	12 26	+91	8 50	83				
26	14	1 2630	2000	2580	3257	8 40	2	6 10	28		7 15	12 25		8 47	89	27			
28	26	4250	2609	2609	3520	8 41	5			13 6	7 39	12 24	—2	8 42	95				
26	36	1 3350	1995	2788		8 16	11	26		14 6	8 3	12 24		8 37	100	28			
39	35	8900	1500	0956	1912	8 26	3		11 56		8 27	12 24	—3	8 31	104				
47	41	1 2100	0200	0500		8 1	10	26			8 50	12 23		8 24	106	29			
32	47	1 3500	2981	0450		8 16			57		9 13	12 23	—3	8 16	*107				
411	337	9 6290	1 5100	2 1669	3 1675	120 23		67	14 70	29	89 37	174 56	+60	119 54	1092				
											+168 0		—8						
											—257 37								
29	24	6876	1079	1548	2263	8 36		9 36	10 4		18 24	12 30	+15	8 34	78 00				
													—3						

## APPENDIX 13.

TABLE XIII.—Tidal Fluctuations at Grondines during the High water season of 1888, viz., from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																	
Gauge book reference numbers. Series VIII. Lowing tides.	High and low waters observed each civil day.	Time, Eastern Standard.	Duration of floods.		Duration of ebbs.		Length of half tide day H. W. to H. W.		Priming- or lagging + of tides	Duration of apparent stand within 0.05 ft.	Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	In duration of floods.	
			H. M.	A. M. or P. M.	H. M.	H. M.	H. M.	Min.									Min.
May 26	H. W.	9 13 P. M.							5		22 1574						
do	L. W.	5 54 A. M.									16 5174		5 6400				
do	L. W.	9 12 A. M.	3 18			9 41	11 50				16 5174	7 3100	5 6400	19 7206	6 2683		
do	L. W.	6 48 P. M.				9 36	12 50				16 5174	7 1700	5 6400	19 5412	6 0075		
do	L. W.	+10 12 P. M.	3 14			9 31	11 56	4			16 5174	4 9450	5 2850	19 3412	6 0075		
do	L. W.	6 33 A. M.	3 25			9 45	13 0				16 5174	6 9700	6 9000	19 3275	5 9100		
do	L. W.	7 43 P. M.	3 15			9 45	13 0				16 5174	4 5050	6 9000	19 1287	5 6825		
do	L. W.	10 53 P. M.	3 15			9 45	11 55	5			16 5174	4 5050	4 7450	19 1287	5 6825		
do	L. W.	7 13 A. M.	3 20			9 45	12 55				16 5174	6 5800	4 7450	18 9256	5 5163		
do	L. W.	11 52 A. M.	3 12			9 45	12 55	9			16 5174	4 1600	6 5800	18 6318	5 2188		
do	L. W.	11 52 P. M.	3 30			9 45	13 1				16 5174	5 8200	5 9250	18 2424	4 9700		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 2800	4 1000	17 8802	4 7633		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	5 2170	4 1000	17 5882	4 6035		
do	L. W.	10 12 A. M.	3 31			9 45	13 1				16 5174	3 7400	5 3570	17 4735	4 5460		
do	L. W.	11 52 A. M.	3 35			9 45	13 1				16 5174	5 3170	3 7700	17 4717	4 4985		
do	L. W.	11 52 P. M.	3 35			9 45	13 1				16 5174	3 6900	5 2470	17 1946	4 1843		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 6225	3 7600		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 A. M.	3 35			9 45	13 1				16 5174	3 6900	4 3500	16 4212	3 9675		
do	L. W.	12 12 P. M.	3 35			9 45	13 1				16 5174	3 6900					

## APPENDIX 13.

TABLE XIII.—Tidal Fluctuations at Grondines during the High water season of 1888, viz., from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS.— Continued.										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."														
Diurnal Inequalities.						Lunital intervals. Oscillations of float in hundredths of a foot.		Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phrases of the moon.				Eastern standard civil times of high water at Quebec, based on best times. (No. 2.)				Length of half tide day H.W. to H.W.		Priming—or lagging + of tides		Lunital intervals.		General coefficients of semi-amplitudes from "L'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.	Series VIII. Losing tides.	Gauge book reference numbers.
In duration of ebb.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.			Upper passage.	Lower passage.	Ages, etc.	Days.	H.	M.	H.	M.									
Min	Min	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.							
			1400												3									
55	51	1 6700	1400	3050	0587	7	44	6	1 23				9 37	12 24		8	9	106	30					
65	54	2 2250	3200	1794	1788	8	4	5		1 58	16	6	10 0	12 23										
74	64	1 7050		2137	1775			3					12 24			3	8	2	104					
80	65	2 3950	0700	1988	2275	7	30	10	2 28				10 24				7	56	101	31				
82	64	1 8350	2400	2031	1662	8	0	6		2 58	17	6	12 24			3	7	50	96					
74	59	*2 4200	0000	2938	2975	7	27		3 26				11 11	12 23			7	45	91	32				
68	61	1 2350	2900	3894	2488	7	58		3 54				11 34			3	7	40	85					
76	62	2 1050	2400	3622	2047	7	31		4 21				11 58	12 24				7	37	79	33			
68	62	1 1170	2 800	2910	1618	8	6		4 47				12 24	12 26			+	2	7 37	72				
76	64	1 6170	1400	1137	0575	7	40		5 12				12 50	12 27				7	38	66	34			
76	64	1 5470	0300	0038	0475	8	17		5 36				1 17	12 30			+	7	7 41	60				
76	71	1 5870	0700	2771	3142	7	51		5 59				1 47	12 32				7	48	55	35			
58	64	3100		5121	* 4243	8	36		6 22				2 19	12 35			+	17	7 57	51				
63	62	4900		2613	2075	8	18		6 44				2 54	12 31				8	10	48	36			
49	53	0400				9	3		7 5				3 25	12 29			+	10	8 20	46				
		4600							23 6															
947	836	22 7180	2 8000	3 6044	2 7725	112	5		29 38	32 40			112 28 + 60 0 = 172 28	186 41				110 10	1060					
67	61	1 5145	1867	2575	1980	8	0		4 14	4 40			12 19	12 27			+	9 - 3	7 52	75-71				
2816	2436	64 2204	9 5100	10 6680	10 5401	482	12		192 50	296 18			704 10	707 42			+	178 - 164 + 14 - 10	479 2	4071				
49	42	1 1267	1698	1905	1882	8	28		6 53	10 13			12 21	12 25				8	24	71 42				

+Moon's S. declination a maximum = 21° 41'. ‡Maximum diurnal inequality observed in high water  
 ebb = 1 318. §Moon's last quarter (Quebec), June 1st, from 7h. 35m. a.m.

## APPENDIX 13.

TABLE XIV.—Tidal Fluctuations at St. Jean des Chaillons during High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

Geographical reference numbers.		DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.													
Station V.	Gaining tides.	High and low waters observed each civil day.	Time, Eastern Standard.	Duration of floods.		Duration of ebbs.		Length of half tide-day H.W. to H.W.		Priming or lagging + of tides.		Duration of apparent stand within 0.05 feet.		Elevation of summits and troughs of fluvial tide-waves.	
				H. M.		H. M.		H. M.		Min.		Feet.		Feet.	
				A.M.	P.M.	A.M.	P.M.	A.M.	P.M.	Min.	Min.	Feet.	Feet.	Feet.	Feet.
		May 5 L.W.	1 15 A.M.	9	3	12	55					70	16	45	
		do 5 H.W.	5 52 A.M.	8	52	12	5			10		20	17	24	
		do 5 L.W.	1 27 P.M.	8	45	9	20					20	16	18	
		do 5 H.W.	5 15 P.M.	8	45	9	12					20	16	18	
		do 6 L.W.	6 13 A.M.	8	48	9	12					20	16	18	
		do 6 H.W.	6 44 A.M.	8	48	9	20					20	16	18	
		do 6 L.W.	6 44 A.M.	8	48	9	20					20	16	18	
		do 6 H.W.	6 44 A.M.	8	48	9	20					20	16	18	
		do 7 L.W.	7 42 A.M.	8	37	9	47			4		20	16	18	
		do 7 H.W.	7 42 A.M.	8	37	9	47			4		20	16	18	
		do 7 L.W.	7 42 A.M.	8	37	9	47			4		20	16	18	
		do 7 H.W.	7 42 A.M.	8	37	9	47			4		20	16	18	
		do 8 L.W.	8 42 A.M.	8	37	9	47			4		20	16	18	
		do 8 H.W.	8 42 A.M.	8	37	9	47			4		20	16	18	
		do 8 L.W.	8 42 A.M.	8	37	9	47			4		20	16	18	
		do 8 H.W.	8 42 A.M.	8	37	9	47			4		20	16	18	
		do 9 L.W.	9 42 A.M.	8	37	9	47			4		20	16	18	
		do 9 H.W.	9 42 A.M.	8	37	9	47			4		20	16	18	
		do 9 L.W.	9 42 A.M.	8	37	9	47			4		20	16	18	
		do 9 H.W.	9 42 A.M.	8	37	9	47			4		20	16	18	
		do 10 L.W.	10 42 A.M.	8	37	9	47			4		20	16	18	
		do 10 H.W.	10 42 A.M.	8	37	9	47			4		20	16	18	
		do 10 L.W.	10 42 A.M.	8	37	9	47			4		20	16	18	
		do 10 H.W.	10 42 A.M.	8	37	9	47			4		20	16	18	
		do 11 L.W.	11 42 A.M.	8	37	9	47			4		20	16	18	
		do 11 H.W.	11 42 A.M.	8	37	9	47			4		20	16	18	
		do 11 L.W.	11 42 A.M.	8	37	9	47			4		20	16	18	
		do 11 H.W.	11 42 A.M.	8	37	9	47			4		20	16	18	
		do 12 L.W.	12 42 A.M.	8	37	9	47			4		20	16	18	
		do 12 H.W.	12 42 A.M.	8	37	9	47			4		20	16	18	
		do 12 L.W.	12 42 A.M.	8	37	9	47			4		20	16	18	
		do 12 H.W.	12 42 A.M.	8	37	9	47			4		20	16	18	
		do 13 L.W.	1 42 P.M.	8	37	9	47			4		20	16	18	
		do 13 H.W.	1 42 P.M.	8	37	9	47			4		20	16	18	
		do 13 L.W.	1 42 P.M.	8	37	9	47			4		20	16	18	
		do 13 H.W.	1 42 P.M.	8	37	9	47			4		20	16	18	
		do 14 L.W.	2 42 P.M.	8	37	9	47			4		20	16	18	
		do 14 H.W.	2 42 P.M.	8	37	9	47			4		20	16	18	
		do 14 L.W.	2 42 P.M.	8	37	9	47			4		20	16	18	
		do 14 H.W.	2 42 P.M.	8	37	9	47			4		20	16	18	
		do 15 L.W.	3 42 P.M.	8	37	9	47			4		20	16	18	
		do 15 H.W.	3 42 P.M.	8	37	9	47			4		20	16	18	
		do 15 L.W.	3 42 P.M.	8	37	9	47			4		20	16	18	
		do 15 H.W.	3 42 P.M.	8	37	9	47			4		20	16	18	
		do 16 L.W.	4 42 P.M.	8	37	9	47			4		20	16	18	
		do 16 H.W.	4 42 P.M.	8	37	9	47			4		20	16	18	
		do 16 L.W.	4 42 P.M.	8	37	9	47			4		20	16	18	
		do 16 H.W.	4 42 P.M.	8	37	9	47			4		20	16	18	
		do 17 L.W.	5 42 P.M.	8	37	9	47			4		20	16	18	
		do 17 H.W.	5 42 P.M.	8	37	9	47			4		20	16	18	
		do 17 L.W.	5 42 P.M.	8	37	9	47			4		20	16	18	
		do 17 H.W.	5 42 P.M.	8	37	9	47			4		20	16	18	
		do 18 L.W.	6 42 P.M.	8	37	9	47			4		20	16	18	
		do 18 H.W.	6 42 P.M.	8	37	9	47			4		20	16	18	
		do 18 L.W.	6 42 P.M.	8	37	9	47			4		20	16	18	
		do 18 H.W.	6 42 P.M.	8	37	9	47			4		20	16	18	
		do 19 L.W.	7 42 P.M.	8	37	9	47			4		20	16	18	
		do 19 H.W.	7 42 P.M.	8	37	9	47			4		20	16	18	
		do 19 L.W.	7 42 P.M.	8	37	9	47			4		20	16	18	
		do 19 H.W.	7 42 P.M.	8	37	9	47			4		20	16	18	
		do 20 L.W.	8 42 P.M.	8	37	9	47			4		20	16	18	
		do 20 H.W.	8 42 P.M.	8	37	9	47			4		20	16	18	
		do 20 L.W.	8 42 P.M.	8	37	9	47			4		20	16	18	
		do 20 H.W.	8 42 P.M.	8	37	9	47			4		20	16	18	
		do 21 L.W.	9 42 P.M.	8	37	9	47			4		20	16	18	
		do 21 H.W.	9 42 P.M.	8	37	9	47			4		20	16	18	
		do 21 L.W.	9 42 P.M.	8	37	9	47			4		20	16	18	
		do 21 H.W.	9 42 P.M.	8	37	9	47			4		20	16	18	
		do 22 L.W.	10 42 P.M.	8	37	9	47			4		20	16	18	
		do 22 H.W.	10 42 P.M.	8	37	9	47			4		20	16	18	
		do 22 L.W.	10 42 P.M.	8	37	9	47			4		20	16	18	
		do 22 H.W.	10 42 P.M.	8	37	9	47			4		20	16	18	
		do 23 L.W.	11 42 P.M.	8	37	9	47			4		20	16	18	
		do 23 H.W.	11 42 P.M.	8	37	9	47			4		20	16	18	
		do 23 L.W.	11 42 P.M.	8	37	9	47			4		20	16	18	
		do 23 H.W.	11 42 P.M.	8	37	9	47			4		20	16	18	
		do 24 L.W.	12 42 P.M.	8	37	9	47			4		20	16	18	
		do 24 H.W.	12 42 P.M.	8	37	9	47			4		20	16	18	
		do 24 L.W.	12 42 P.M.	8	37	9	47			4		20	16	18	
		do 24 H.W.	12 42 P.M.	8	37	9	47			4		20	16	18	
		do 25 L.W.	1 42 A.M.	8	37	9	47			4		20	16	18	
		do 25 H.W.	1 42 A.M.	8	37	9	47			4		20	16	18	
		do 25 L.W.	1 42 A.M.	8	37	9	47			4		20	16	18	
		do 25 H.W.	1 42 A.M.	8	37	9	47			4		20	16	18	
		do 26 L.W.	2 42 A.M.	8	37	9	47			4		20	16	18	
		do 26 H.W.	2 42 A.M.	8	37	9	47			4		20	16	18	
		do 26 L.W.	2 42 A.M.	8	37	9	47			4		20	16	18	
		do 26 H.W.	2 42 A.M.	8	37	9	47			4		20	16	18	
		do 27 L.W.	3 42 A.M.	8	37	9	47			4		20	16	18	
		do 27 H.W.	3 42 A.M.	8	37	9	47			4		20	16	18	
		do 27 L.W.	3 42 A.M.	8	37	9	47			4		20	16	18	
		do 27 H.W.	3 42 A.M.	8	37	9	47			4		20	16	18	
		do 28 L.W.	4 42 A.M.	8	37	9	47			4		20	16	18	
		do 28 H.W.	4 42 A.M.	8	37	9	47			4		20	16	18	
		do 28 L.W.	4 42 A.M.	8	37	9	47			4		20	16	18	
		do 28 H.W.	4 42 A.M.	8	37	9	47			4		20	16	18	
		do 29 L.W.	5 42 A.M.	8	37	9	47			4		20	16	18	
		do 29 H.W.	5 42 A.M.	8	37	9	47			4		20	16	18	
		do 29 L.W.	5 42 A.M.	8	37	9	47			4		20	16	18	
		do 29 H.W.	5 42 A.M.	8	37	9	47			4		20	16	18	
		do 30 L.W.	6 42 A.M.	8	37	9	47			4		20	16	18	
		do 30 H.W.	6 42 A.M.	8	37	9	47			4		20	16	18	
		do 30 L.W.	6 42 A.M.	8	37	9	47			4		20	16	18	
		do 30 H.W.	6 42 A.M.	8	37	9	47			4		20	16	18	
		do 31 L.W.	7 42 A.M.	8	37	9	47			4		20	16	18	
		do 31 H.W.	7 42 A.M.	8	37	9	47			4		20	16	18	
		do 31 L.W.	7 42 A.M.	8	37	9	47			4		20	16	18	
		do 31 H.W.	7 42 A.M.	8	37	9	47			4		20	16	18	

N.B. Mean time of high water is indicated by a star (\*) and minima by a circle (o).  
 Report of St. Jean des Chaillons, 1888. Mean time of high water is indicated by a star (\*) and minima by a circle (o

## APPENDIX 13.

TABLE XIV.—Tidal Fluctuations at St. Jean des Chaillons during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued.)										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."											
Diurnal Inequalities.					Lunital intervals.		Oscillations of float in hundredths of a foot.	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times, No. 2	Length of half tide day H. W. to H. W.	Priming—or lagging—of tides	Lunital intervals.		General coefficient of semi-amplitude from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.	Series III. Gaining tides.	Gauge book reference numbers.			
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.				Upper passage.	Lower passage.	Ages, etc.											
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.					
59		21	01	15	9	27	10			7	40	23 3	4	37			12 42				
48	66	03	06	02	9	9	9	8	3			23 3	5	18			*12 41	*+33	8 57		
31	42	12			9	41				8	24	24 3	5	35			12 37		9 15		
05	05	20	14	04	9	41				8	46		6	27			12 32	+19	9 31		
9	03	01	02	18	9	47	4			9	7	25 3	6	54			12 27		9 41		
11	27	16	16	15	9	53	1			9	28		7	19			12 25	+2	9 47		
4	38	05	14	07	9	48						26 3	7	41			12 22		9 51		
10	33	08	18	48	9	47				9	49		7	41			12 20	—8	9 52		
19	1 33		09	41	9	47				10	10		8	1			12 18		9 51		
20	1 78	15	54	70	9	38						27 3	8	19			12 18	—14	9 50		
6	1 34	23	68	81	9	45				10	51		8	37			12 18		9 50		
10	12	32	43	20	9	32	5					28 3	8	53			12 16		9 46		
27	1 02	34	26	09	9	26	15			11	13		9	10			12 16	—17	9 40		
34	1 03	28	12	10	9	9	20					29 3	9	25			12 17		9 36		
	1 29	05	24	02	9	18	20			11	56		9	25			12 15	—19	9 29		
							15			19		0 6	9	41			12 16		9 22		
																	12 15				
27	10 07	2 23	3 07	3 42	134	1	....			71	11	68 38	....	106	17	173	19	+54	134	28	912
20	72	16	22	25	9	34	....			10	10	9 48	....	7	36	12	23	+58			
																		+18			
																		—15			

Moon in apogee May 9th, at 8h. 0m., p.m.

New moon (Quebec) May 10th, at 8h. 24m., p.m.



## APPENDIX 13.

TABLE XIV.—Tidal Fluctuations at St. Jean des Chaillons during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."															
Diurnal Inequalities.					Lunital intervals.		Oscillations of float in hundredths of a foot.		Eastern standard civil times of meridian passages immediately preceding observed high water, with corresponding ages and phases of the moon.					Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2)		Length of half tide day H. W. to H. W.		Priming—or lagging—of tides		Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.		Series V.L. Losing tides.	Gauge book reference numbers.
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.					Upper passage.	Lower passage.	Ages, etc.	H.	M.												
Min.	Feet.	Feet.	Feet.	Feet.	H.	M.			H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min	H.	M.					
36		45			8	54	10				41		1 6	9 56			* 19	9	15						
43	65	45	41	09	9	5	10	6	1	4				10 12	12	16		9	8					16	
56	1 48		36	23			3							10 27	12	15		8	59						
59	1 29		27	16	8	32				1 28	2 6			10 43	12	16		8	51					17	
56	1 81		15	01	8	55				1 52				10 59	12	16		8	42						
46	1 73		13		8	18	12			2 17			3 6	10 59	12	16		18	8	42				78	
55	1 38		39		8	37	18	2	42					11 15	12	16		8	33					18	
63	1 17	26	05	14	8	10				3 7	4 6			11 31	12	16		16	8	24				73	
59	1 00		06	18	8	38			3 32					11 49	12	18		8	17					19	
59	1 26	05	15	15	8	2				3 58	5 6			12 7	12	19		13	8	9				66	
79	75	19	16	14	8	26			4 23					12 26	12	22		8	3					20	
71	1 20	01	13	11	7	59				4 49	6 6			12 48	12	24		4	7	59				58	
63	92	13	08	02	8	42			5 15					1 12	12	26		7	57					21	
53	95	01	01	06	8	15				5 40	7 6			1 38	12	26		+ 6	7	58				51	
51	99	12	05	09	8	51	2	6	5					2 8	12	30		8	3					22	
42					8	35				6 31	8 6			2 42	12	34		+ 22	8	11				46	
329	16 48	2 89	2 13	2 08	127	59			24	53	40 31		131 53	172	46	+ 28	126	29	1007						
											84 0		+ 48 0												
											-124 31		-179 53			-89									
55	1 18	21	15	15	8	32			3	33	15 34		12 0	12	20	+ 14	8	26	67	13					
																-15									

\* Moon's north declination a maximum = 21° 8'.

† Moon's first quarter (Quebec), May 18th, from 6h. 5m. p.m.



## APPENDIX 13.

TABLE XIV.—Tidal Fluctuations at St. Jean des Chaillons during the High water season of 1888, viz.:—from quadrature of May 2nd to quadrature of June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS —(Continued)										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."													
Diurnal Inequalities.										Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.													
										Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2)													
										Length of half tide day H.W. to H.W.													
										Priming—or lagging + of tides													
										Lunital intervals.													
										General coefficients of semi-amplitudes from "l'Annuaire des Mares," corresponding to observed tides assumed to be 48 hours old.													
										Change book reference numbers.													
										Series VII. Gaining tides.													

## APPENDIX 13.

TABLE XIV.—Tidal Fluctuations at St. Jean des Chaillons during the High water season of 1888, viz., from quadrature May 2nd, to quadrature June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																												
Gauge book reference numbers. Series VIII. Lowing tides.		High and low waters observed each civil day.	Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide day H. W. to H. W.		Priming—or lagging + of tides		Duration of apparent stand within 0.05 feet.		Elevations of summits and troughs of fluvial tide waves.		Ranges of floods.		Ranges of ebbs.		Mean tide levels corrected for diurnal inequalities.		Mean amplitudes corrected for diurnal inequalities.		In duration of floods.		In duration of ebbs.	
			H.	M. OR P.M.	H.	M.	H.	M.	H.	M.	Min.	Min	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Min	Min	Min	Min		
	May 26 H. W		9 38 P.M.								5		22.86															
30	May 27 L. W.		6 25 A.M.				8 47	12 0				44	19 23			3 63							10					
	do 27 H. W		9 38 A.M.	3 13								19	24 36	5 13				21 40	4 22									
	do 27 L. W.		7 21 P.M.				9 43	12 48				35	19 35			5 01							8					
31	do 27 H. W	+	10 26 P.M.	3 5							4	32	22 44	3 09				21 24	4 08									
	do 28 L. W.		7 11 A.M.				8 45	12 0				33	19 06			3 38							10					
	do 28 H. W		10 26 A.M.	3 15								20	23 88	4 82				21 07	3 98									
32	do 28 L. W.	++	8 14 P.M.				9 48	12 58				58	19 15			4 73							5					
	do 28 H. W		11 24 P.M.	3 10							6	30	21 93	2 78				20 90	3 72									
	do 29 L. W.		7 59 A.M.				8 35	11 58				46	18 95			2 98							13					
33	do 29 H. W		11 22 A.M.	3 23								21	23 32	4 37				20 72	3 57									
	do 29 L. W.		9 11 P.M.				9 49	13 0				45	18 91			4 41							12					
	do 29 H. W		12 22 A.M.	3 11							5	26	21 43	2 52				20 44	3 35									
34	do 30 L. W.		8 57 A.M.				8 35	11 55				45	18 63			2 80							9					
	do 30 H. W		12 17 P.M.	3 20								30	22 28	3 65				20 09	3 14									
	do 30 L. W.		10 7 P.M.				9 50	13 5				39	18 40			3 82							5					
35	do 31 H. W		1 22 A.M.	3 15							8	42	20 60	2 20				19 73	2 98									
	do 31 L. W.		9 50 A.M.				8 28	11 53				46	18 09			2 51							10					
	do 31 H. W		1 15 P.M.	3 25								34	21 40	3 31				19 46	2 64									
36	do 31 L. W.		10 57 P.M.				9 42	12 57				46	17 98			3 42							10					
	June 1 H. W.		2 12 A.M.	3 15							12	56	20 10	2 12				19 34	2 79									
	do 1 L. W.		10 45 A.M.				8 33	12 5				56	17 91			2 19							17					
37	do 1 H. W.		2 17 P.M.	3 32								37	21 32	3 41				19 32	3 77									
	do 1 L. W.		11 53 P.M.				9 36	13 0				42	17 93			3 39							8					
	do 2 H. W.		3 17 A.M.	3 24							20	43	20 10	2 17				19 07	2 60									
38	do 2 L. W.		12 3 A.M.				8 46	12 10				58	17 62			2 48							0					
	do 2 H. W.		3 27 P.M.	3 24								42	19 95	2 33				18 52	2 43									
	do 3 L. W.		12 52 A.M.				9 25	13 5				57	17 23			2 72							16					
39	do 3 H. W.		4 32 A.M.	3 40							25	42	19 41	2 18				18 40	2 42									
	do 3 L. W.		1 0 P.M.				8 28	12 10				53				2 27							2					
	do 3 H. W.												17 14															
Totals 14 tides.			96 17 + 24			46 32	136 50	187 4			76	474	302 52			44 08	49 80	279 70	45 64	135 90								
			-120 17																									
			134 45 - 12								4	703	258 44															
			=146 45																									
Means			14 H. W.			3 19	9 7	12 29			13	34	21 61			3 15	3 32	19 98	3 36	9 65								
do			15 L. W.								3	47	18 46															
Grand totals 57 tides.						196 33	511 12	707 35			178	2083	1218 07			168 69	168 00	1134 39	169 52	520 273								
do												158	2815	1050 53														
Grand means do						3 27	8 58	12 25			13	37	21 37			2 96	2 94	19 90	2 98	9 47								
do											11	49	18 43															

N. B. — Maxima in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °  
 + Moon's S. declination a maximum = 21° 41'.

## APPENDIX 13.

TABLE XIV.—Tidal Fluctuations at St. Jean des Chaillons during the High water season of 1888, viz., from quadrature May 2nd, to quadrature June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued.)					RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."									
Diurnal inequalities.					Lunital intervals. Oscillations of float in hundredths of a foot.	Eastern standard civil times of meri- dian passages im- mediately preced- ing observed high waters, with cor- responding ages and phases of the moon.			Eastern standard civil times of high water at Quebec, based on Brest times, No. 2.	Length of half tide day H. W. to H. W.	Priming—or lagging + of tides	Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Mares," cor- responding to observed tides assum- ed to be 48 hours old.
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.		Upper passage.	Lower passage.	Ages, etc.				H. M.	M.	
Min	Feet.	Feet.	Feet.	Feet.	H. M.	H. M.	H. M.	Days.	H. M.	H. M.	Min.	H. M.	M.	
		16									3			
48	1 50	12	02	00	8 10	3	1 28		10 2	12 24		8 34	106	30
48	1 92	29	16	14	8 27	5		16 6	10 25	12 23	3	8 26	104	
58	1 44	09	17	15	7 57	2	2 29		10 49	12 24		8 20	101	31
60	1 95	20	17	21	8 26	15		17 6	11 13	12 24		8 15	96	
62	1 39	04	18	15	7 55	1				12 23	3	8 15	96	
65	1 89	28	28	22	8 28				11 36	12 23		8 9	91	32
70	85	28	35	21	8 28			3 54	11 59	12 24	3	8 5	85	
72	1 68	31	36	16	7 56			4 21	12 23	12 26		8 2	79	33
64	80	11	27	34	8 35			4 47	12 49	12 26	2	8 2	72	
52	1 30	07	12	15	8 3			5 12	1 15	12 27		8 3	66	34
55	1 22	02	02	98	8 36	10		5 36	1 42	12 30	7	8 6	60	
55	1 22	02	25	1 17	8 18			5 59	2 12	12 32		8 13	55	35
55	15	31	55	17	8 55			6 22	2 44	12 35	17	8 22	51	
55	54	09	12	01	8 43			6 44	3 19	12 31		8 35	48	36
	24				9 27			7 5	3 50	12 29	10	8 45	46	
814	18 09	2 71	3 02	4 06	117 56			29 40	32 41	106 28 186 41	36	115 57	1060	
										+ 72 0				
										= 178 18		9		
58	1 20	18	22	29	8 25			4 14	4 40	12 44	12 27	8 17	75 71	
237	51 73	9 19	10 21	11 97	506 26			193 1	206 21	727 55 707 42	178	502 33	4071	
40	91	16	18	21	8 53			6 51	7 19	12 46	12 25	8 49	71 42	
											10			

∴ Maximum diurnal inequality in high water levels observed = 1 93 ft  
 & Moon's last quarter (Quebec) June 1st, from 7h. 58m. a.m.

## APPENDIX 13.

TABLE XV.—Tidal Fluctuations at Batiscan during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																					
(Gauge book reference numbers. Series V. (gaining tides.)	High and low waters observed each civil day.	Time, Eastern Standard.		Duration of floods.	Duration of ebbs.		Length of half tide day H. W. to H. W.		Priming- or lagging + of tides	Duration of apparent stand within 0.05 feet.	Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.		Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	In duration of floods.				
		H.	M.		A.M. or P.M.	H.	M.	H.				M.	Min.					Min.	Feet.	Feet.	Feet.
4	May 5 L.W. a	2	29	A.M.			8	52	12	54		81	19	8175							
5	May 5 H.W. b	6	31	A.M.	4	2				+ 18	97	20	5585	7410		20 2393	1 0135				
	do 5 L.W. c	2	34	P.M.			8	3	12	14		68	19	6475		9110					
	do 5 H.W. d	6	45	P.M.	4	11					107	20	8885	1 2410		20 2151	1 1070				
	do 6 L.W. e	3	21	A.M.			8	36	13	8		77	19	6735		1 2130					
10	do 6 H.W. f	7	53	A.M.	4	32				- 17	122	20	7385	1 0630		20 1654	1 1068				
	do 6 L.W. g	3	54	P.M.			8	1	11	59		75	19	5485		1 1900					
	do 6 H.W. h	7	52	P.M.	3	58					100	20	5095	9610		20 0364	1 0558				
	do 7 L.W. i	4	18	A.M.			8	26	12	37		95	19	4685		1 0410					
11	do 7 H.W. j	8	29	A.M.	4	11				- 16	107	20	4995	1 0310		20 0063	1 0755				
	do 7 L.W. k	4	33	P.M.			8	4	12	29		145	19	4685		1 0310					
	do 7 H.W. l	8	58	P.M.	4	23					106	20	6285	1 1600		20 0848	1 1525				
	do 8 L.W. m	5	1	A.M.			8	3	11	43		75	19	5485		1 0800					
12	do 8 H.W. n	8	41	A.M.	3	40				- 26	84	20	6875	1 3390		20 1943	1 2025				
	do 8 L.W. o	5	27	P.M.			8	46	12	41		75	19	6375		1 2500					
	do 8 H.W. p	9	22	P.M.	3	55					71	20	7785	1 1410		20 2911	1 2370				
	do 9 L.W. q	5	25	A.M.			8	3	11	55		60	19	7075		1 0710					
13	do 9 H.W. r	9	17	A.M.	3	52				- 21	88	21	1935	1 4860		20 4353	1 2885				
	do 9 L.W. s	5	55	P.M.			8	38	12	34		63	19	8755		1 3180					
	do 9 H.W. t	9	51	P.M.	3	56					95	21	1545	1 2790		20 6579	1 4148				
	do 10 L.W. u	5	58	A.M.			8	7	11	40		98	20	0255		1 1290					
14	do 10 H.W. v	9	31	A.M.	3	33				- 43	21	9585	1 9330		20 9645	1 6010					
	do 10 L.W. w	6	25	P.M.			8	54	12	27		71	20	3025		1 6560					
	do 10 H.W. x	9	58	P.M.	3	33					72	21	9985	1 6960		21 3185	1 7260				
	do 11 L.W. y	6	16	A.M.			8	18	11	51		62	20	6085		1 3900					
15	do 11 H.W. z	9	49	A.M.	3	33				- 12	62	22	7705	2 1620		21 6069	1 6788				
	do 11 L.W. aa	7	4	P.M.			9	15	12	47		74	20	9265		1 8440					
	do 11 H.W. bb	10	36	P.M.	3	32					70	22	2455	1 3190		21 7701	1 6482				
	do 12 L.W. cc	6	54	A.M.			8	18	11	50		60			1 2800						
Totals 14 tides		H.W.	123	33			54	53	117	32	171	55	- 51	1288	296	8100	18 5520	17 4040	20 5704	1 3077	13
		L.W.	73	5									102	1109	278	2580					
Means		14 H.W.					8	55	8	24	12	17	- 17	92	21	2007	1 3251	1 2431	20 5704	1 3077	13
		14 L.W.											- 26	74	19	8756					

N.B. Maxima in whole lunar month indicated by a star, thus: \* and minima by a circle, thus: °  
 a Longitude, Batiscan, Brunelles wharf 72° 13' 44.49m. (6. 0 200' of a day west of Greenwich.  
 b Stiff N.E. breeze; sky overcast; appearance of rain. c Light N.E. breeze; rain.  
 d N.E. breeze; rain continues. e Sky clouded. f Fine, clear weather.  
 g Cloudy; N.E. wind, hardly perceptible. h Feeble S.W. breeze; cloudy.  
 i Fine, bright, cool weather. Gusts of N.E. wind; fair.  
 k Moon crosses the equator, wind, N.W. breeze; fair. m Fine, bright morning.  
 n Very light S. wind. o Gentle S.W. breeze; sky clear; sky warm.

## APPENDIX 13.

TABLE XV.—Tidal Fluctuations at Batiscan during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS—(Continued).						RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."																							
Diurnal Inequalities.						Lunital intervals.		Oscillations of float in hundredths of a foot.		Upper passage.		Lower passage.		Ages, etc.		Eastern standard civil times of high water at Quebec, based on Brest time: (No. 2.)		Length of half tide-day H.W. to H.W.		Priming— or lagging + of tides		Lunital intervals.		General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.		Series V. Gaining tides. Gauge-book reference numbers.			
Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	H.	M.	H.	M.	Days.	H.	M.	H.	M.	Min.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
														23	3														
49	40		1700			10	50			7	41				5	44			+ 33		10	3		44					
43	54	3300	0280	0242	0935	10	42	8	3					24	3	6	25			*12	41		10	22		46			
35	69	1500		0497	0002	11	28			8	25					7	2			+ 19		10	37		49				
25	32	2290	1270	1290	0510	11	6	8	46					25	3	7	34				12	32		10	48		53		10
12	8	0100		0301	0197	11	21			9	8					8	1				12	27		10	53		57		
1	46	1290	0800	0785	0770	*11	30	9	28					26	3	8	26				12	25		10	58		61		11
43	58	2500	0890	1095	0500	10	52			9	49					8	48				12	22		8	*10	59		65	
43	46	1090	0700	0968	0345	11	12	10	10					27	3	9	8				12	20		10	58		69		12
30	34	4150	1680	1442	0515	10	46			10	31					9	26				12	18		14	10	55		72	
26	49	0390		2226	1263	10	59	10	52					28	3	9	44				12	16		10	52		75		13
47	47	8040	2770	3006	1862	10	18			11	13					10	0				12	17		17	10	47		78	
36	36	0400		3540	1250	10	23	4	11	35				●		10	17				12	15		10	42		80		14
57	56	7720	3060	2884	0472	9	52	7	11	37				29	3	10	32				12	15		19	10	35		81	
57	57	5250	3180	1632	0306	10	17	5	19					0	6	10	48				12	16		10	29		82		15
		8700		2538	0026			6													12	15							
64	638	4	6810	1	9020	2	2506	8953	151	36	71	13	68	44		121	55	160	96		+ 54		149	58		912			
36	46	3344	1359	1608	0640	10	50	10	10	9	49					8	43	11	50		+ 18		10	43	65	14			

p S.W. breeze, very feeble; fine, clear sky; warm. q N. wind, very feeble; fine weather.  
 r Light S.W. breeze; fine, clear weather. s Light S.W. breeze; fine, clear weather; warm.  
 t Light S.W. breeze; fine, clear weather; warm. Moon in apogee, May 9th, at 8 0 p.m.  
 u Brisk N.E. breeze; sky overcast. v Strong N.E. wind; rain. w N.E. wind; cloudy; fair.  
 x Very strong N.E. breeze; cloudy. New moon (Quebec), May 10th, at 8 24 p.m.  
 y Sky overcast; fair; high N.E. wind. z Strong N.E. breeze; fine and bright.  
 aa Brisk N.E. breeze; sky overcast; appearance of rain.  
 ab Brisk N.E. breeze; fine, clear weather. ac High N.E. wind; rain.

## APPENDIX 13.

TABLE XV.—Tidal Fluctuations at Batiscan during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																				
Gauge book reference numbers. Series VI. Lowing tides.	High and low waters observed each civil day.	Time, Eastern Standard	Duration of floods.		Duration of ebbs.	Length of half tide-day H. W. to H. W.		Priming or lagging + of tides		Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	In duration of floods.					
			H. M.			H. M.	H. M.	Min	Min							Feet.	Feet.	Feet.	Feet.	Min
			H.	M.		H.	M.	H.	M.							Min	Min	Feet.	Feet.	Feet.
	May 12 L.W.	6 54 A.M.							- 12											
	May 12 H.W. a	10 26 A.M.	3	32				3	50	23 1155	2 1500		22 0239	1 6508						
16	do 12 L.W. a	7 27 P.M.			9	1	13	3	58	21 4315		1 6840	22 4548	1 5661						
	do 13 H.W. b	11 29 P.M.	4	2					67	22 9205	1 4890									
	do 13 L.W. c	7 45 A.M.			8	16	11	16	67	21 9200		1 0005								
17	do 13 H.W. c	10 45 A.M.	3	0				- 34	67	24 0105	2 0905		22 8752	1 4469						
	do 13 L.W. d	8 7 P.M.			9	22	13	0	60	22 3835		1 6270								
	do 14 H.W. e	11 45 P.M.	3	38					73	23 4530	1 0695		23 1647	1 4053						
18	do 14 L.W. f	7 38 A.M.			8	13	11	44	45	22 5405		0 9125	23 3465	1 4519						
	do 14 H.W. g	11 29 A.M.	3	31				- 35	73	24 5525	2 0120									
	do 14 L.W. h	8 38 P.M.			9	09	13	41	84	22 7005		1 8520								
19	do 15 H.W. i	11 10 A.M.	4	32					110	23 7315	1 0310		23 5682	1 2315						
	do 15 L.W. j	8 17 A.M.			7	7	11	10	85	23 2055		0 5206								
	do 15 H.W. k	12 30 P.M.	4	3				- 17	64	24 7225	1 5170		23 8302	1 6313						
20	do 15 L.W. k	9 33 P.M.			9	13	* 13	23	76	23 4235		1 2990								
	do 16 H.W. l	1 43 A.M.	4	10					107	24 2065	0 7890		23 9565	1 0660						
	do 16 L.W. l	8 55 A.M.			7	12	11	33	61	23 4835		0 7230								
21	do 16 H.W. m	1 16 P.M.	4	21				- 27	102	24 7025	1 3190		23 9824	0 8898						
	do 16 L.W. m	10 27 P.M.			9	11	12	50	82	23 5915		1 1110								
	do 17 H.W. n	2 6 A.M.	3	39					113	24 6975	0 5060		23 9292	0 8233						
22	do 17 L.W. o	9 47 A.M.			7	41	12	5	90	23 4435		0 6540								
	do 17 H.W. o	2 11 P.M.	4	24				- 26	90	24 4655	1 0220		23 8375	0 7800						
	do 17 L.W. o	11 17 P.M.			9	6	13	11	95	23 4515		1 0140								
23	do 18 H.W. p	3 22 A.M.	4	5					111	23 8815	0 4390		23 7570	0 7380						
	do 18 L.W. q	10 32 A.M.			7	30	11	57	70	23 3245		0 5570								
	do 18 H.W. q	3 19 P.M.	4	27				- 9	87	24 2755	0 9510		23 6735	0 7410						
24	do 18 L.W. q	12 26 P.M.			9	7	12	44	105	23 2555		0 9900								
	do 19 H.W. r	4 3 A.M.	3	37					93	23 7515	0 4660		23 6157	0 7905						
	do 19 L.W. r	11 38 A.M.			7	55	12	33	103	23 1555		0 5960								
	do 19 H.W. r	4 36 P.M.	* 4	38				- 23	96	24 2655	1 1100		23 6362	0 8167						
	H.W.	92 0 60							- 27	126 360 1520										
	L.W.	132 0																		
	Totals 15 tides		30	69	118	3	174	10		17 9460	14 5460	351 6575	16 4291	470						
	do	133 27							- 27	1067 342 3060										
	Means 15 H.W.							- 21	86	24 0101										
	do		3	39	8	26	12	26		1 1964	1 0390	23 4438	1 0953	34						
	14 L.W.								22	78 22 8294										

N.B. Maxima in whole lunar month, indicated by a star, thus: \* Minima by a circle, thus: °

+ Moon's N. declination a maximum, 21 °. Maximum diurnal inequality observed in low water levels 0.565. † Moon's first quarter (sheeb), May 18th, from 6h. 5m., p.m.

TABLE XV.—Tidal Fluctuations at Batiscan during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

*a.* High N.E. wind; rain. *b.* N.E. breeze; rainy weather. *c.* Gentle N.E. breeze; rain. *d.* Feeble N.E. wind. *e.* N.E. wind with rain. *f.* N.E. breeze with showers of rain. *g.* High N.E. wind; heavy rain. *h.* High N.E. wind; sky overcast. *i.* High N.E. wind; wet weather. *j.* N.E. breeze, accompanied by rain. *k.* Gentle S.W. breeze; fair. *l.* N.W. wind; fine. *m.* Light S.W. wind; fine day. *n.* S.W. wind just perceptible; fine. *o.* Gentle N.W. breeze. *p.* Gentle N.W. wind; clear bright sky. *q.* Light N.W. breeze; fine clear weather. *r.* Fresh N.W. breeze; fine clear weather. *s.* Feeble S. breeze; wet weather. *t.* N.E. breeze; showers of rain.



## APPENDIX 13.

TABLE XV.—Tidal Fluctuations at Batiscan during the High water season of 1888, viz.:—from quadrature of May 2nd to quadrature of June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."									
Diurnal Inequalities.										Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.									
In duration of flood.	In duration of ebb.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.	Lunital intervals.	Oscillations of float in hundredths of a foot.	Upper passage.	Lower passage.	Ages, etc.	Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)	Length of half tide day H. W. to H. W.	Priming—or lagging—of tides	Lunital intervals.	General coefficients of semi-amplitudes from "L'Annuaire des Mares" corresponding to observed tides assumed to be hours old.	Series VII. Gauging tides.	Gauge book reference numbers.	
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	H. M.	H. M.	H. M.	H. M.	Days	H. M.	H. M.	Min.	H. M.				
42	31	21	0.3700	0.1455	0.0413	0.0725	10 19		6 57				12 38	22	9 30	46	23		
10	17	33	0.0840	0.1550	0.1546	0.0003	10 13	2		7 22	9 6	4 27	12 40	29	9 45	48	24		
16	25	34	0.0800	0.0600	0.0718	0.0715	10 39		7 48		10 6	5 46	12 37		9 58	51	25		
20	30	17	0.1000	0.0900	0.0250	0.1000	10 31			8 14		6 23	12 34	21	10 9	56	26		
13	6	15	0.0200	0.0300	0.0300	0.0600	10 40		8 40		11 6	6 57	12 31		10 17	62	27		
9	21	25	0.0600	0.0600	0.0030	0.0960	10 34			9 6		7 28	12 28	9	10 22	69	28		
4	58	33	0.3440	0.0100	0.0406	0.1310	10 12		9 33		12 6	7 56	12 26	1	10 21	83	29		
25	50	23	0.2040	0.1100	0.0348	0.1698	10 12	3		10 1		8 22	12 25		10 18	89	30		
5	64	34	0.5430	0.1500	0.0942	0.1482	9 49	2	10 29		13 6	8 47	12 24		10 13	95	31		
30	38	39	0.2090	0.0600	0.1089	0.1280	9 59			10 58		9 11	12 24	2	10 13	95	32		
1	45	38	0.5670	0.1000	0.0698	0.0658	9 30		11 27		14 6	9 35	12 24		10 8	100	33		
7	49	43	0.4470	0.1605	0.0257	0.0458	9 38	3		11 57		9 59	12 23	3	10 2	104	34		
6	67	73	0.6545	0.0705	0.0165	0.0669	9 3	3	27		15 6	10 22	12 23		9 55	106	35		
6	74	93	0.8145		0.0015	0.0466	9 40	1		58		10 45		3	9 47	107	36		
305	575	521	4 4970	1 3550	0 7177	1 1924	140 59		67 21	70 36		111 5 174 56		60	141 8 1092				
												168 0		8					
												279 5							
15	41	37	0.3212	0.0968	0.0613	0.0852	10 4		9 37	10 5		19 56	12 30	15	10 5 78 00				
														3					

Very feeble N.E. breeze; fair. m Very feeble S.W. breeze; fine. n Very light N.E. wind; clear sky.  
 o N.E. breeze; fair. p N.E. breeze; fair; moon in perigee, May 24th, at 2 p.m.  
 q Gentle N.E. breeze; fine and bright. r N.E. wind hardly perceptible; fine clear sky.  
 s N.E. wind hardly perceptible; fine clear sky; full moon (Quebec), May 25th, at 8.40 a.m.  
 t N.E. breeze; fair. u Fresh N.E. breeze; fair. v Stiff N.E. breeze; fair.

## APPENDIX 13.

TABLE XV.—Tidal Fluctuations at Batiscan during High water season of 1888, viz.:  
—from quadrature, May 2nd, to quadrature, June 1st.

Gauge book reference numbers. Series VIII. Leasing tides.		DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.															
		High and low waters observed each civil day.	Time, Eastern Standard.			Duration of floods.		Duration of ebbs.		Length of half tide day H.W. to H.W.		Priming—or lagging—of tides		Elevations of summits and troughs of fluvial tide waves.	Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.
			H.	M.	A.M. or P.M.	H.	M.	H.	M.	H.	M.	Min.	Min.				
30	M'y 26	H. W.	10	38	P.M.							-7		24 1855			
	M'y 27	L. W.	7	9	A.M.			8	31	11	35		62	22 6305		1 5550	
	do 27	H. W.	10	13	A.M.	3	4						35	25 2475	*2 6170		23 6655
31	do 27	L. W.	8	8	P.M.			9	55	12	56		50	22 7005		*2 5470	
	do 27	H. W.	11	9	P.M.	3	1					+9	57	23 9815	1 2810		23 5510
	do 28	L. W.	7	53	A.M.			8	44	12	3		62	22 4725		1 5090	
32	do 28	H. W.	11	12	A.M.	3	19						45	24 8512	2 3787		23 4217
	do 28	L. W.	8	58	P.M.			9	46	12	55		56	22 5415		2 3097	
	do 29	H. W.	12	7	A.M.	3	9					+10	69	23 6615	1 1200		23 3167
33	do 29	L. W.	8	32	A.M.			8	25	12	5		55	22 4205		1 2410	
	do 29	H. W.	12	12	P.M.	3	40						56	24 4355	2 0150		23 1658
	do 29	L. W.	9	50	P.M.			9	38	13	6		62	22 3335		2 1020	
34	do 30	H. W.	1	18	A.M.	3	28					+6	87	23 2855	0 9520		22 9382
	do 30	L. W.	9	38	A.M.			8	20	11	50		43	22 0755		1 2100	
	do 30	H. W.	1	8	P.M.	3	30						38	23 6815	1 6060		22 6494
35	do 30	L. W.	10	57	P.M.			9	49	13	22		53	21 8775		1 8040	
	do 31	H. W.	2	30	A.M.	3	33					+28	78	22 6405	0 7630		22 3585
	do 31	L. W.	10	32	A.M.			8	2	11	56		61	21 5815		1 0590	
36	do 31	H. W.	2	26	P.M.	3	54						83	22 9875	1 4060		22 1684
	do 31	L. W.	11	51	P.M.			9	25	12	48		80	21 6615		1 3260	
	June 1	H. W.	3	14	A.M.	3	23					-4	110	22 2455	0 5840		22 0882
37	do 1	L. W.	11	22	A.M.			8	8	11	58		75	21 3715		0 8740	
	do 1	H. W.	3	12	P.M.	3	50						107	22 9205	1 5490		21 9493
	do 2	L. W.	12	49	A.M.			9	37	13	18		78	21 3245		1 5960	
38	do 2	H. W.	4	30	A.M.	3	41					*+38	93	22 1155	0 7910		21 7314
	do 2	L. W.	12	51	P.M.			8	21	12	10		92	21 0555		1 0600	
	do 2	H. W.	4	40	P.M.	3	49						87	21 9395	0 8840		21 4025
39	do 3	L. W.	1	43	A.M.			9	3	13	6		89	20 7685		1 1710	
	do 3	H. W.	5	46	A.M.	4	3					+33	93	21 5785	0 8100		21 1976
	do 3	L. W.						8	7	12	17		93			0 9200	
Totals 14 tides.	H. W.	85	37	-24								+124	1038	325 5717	18 7567	22 2837	315 6043
	L. W.	=109-37			49	24	133	51	187	25		-4	1011	306 8150			
	L. W.	=134-6+24															
Means do	14 H. W.											+21	74	23 2551			
	15 L. W.				3	32	8	55	12	30		-4	67	21 9154	1 3398	1 4856	22 5432
	L. W.	=158-6															
Grand totals 57 tides.	H. W.				215	50	491	34	707	32		+286	4890	1320 3372	73 0672	72 1262	1244 1568
	L. W.										-270	4307	1247 3700				
	57 H. W.										+19	86	23 1638				
Grand means do	57 L. W.				3	47	8	37	12	25		-18	76	21 8837	1 2819	1 2654	22 5291
	L. W.																
	57 L. W.																

N. B.—Maxima in whole lunar month indicated by a star, thus: \*; and minima by a circle, thus: °.

## APPENDIX 13.

TABLE XV.—Tidal Fluctuations at Batiscan during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.— <i>Con.</i>									
Diurnal Inequalities.									
Mean amplitudes corrected for diurnal inequalities.							REMARKS.		
	In duration of floods.	In duration of ebbs.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.			
Feet.	Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.		
						0 1200			
*2 6000	19			1 0620		0 0070	0 0359	Feeble N.E. wind with rain	
		84	81		0 0700			Maximum diurnal inequality in high water levels observed = 1 266. N.E. breeze, fair	30
1 9229	3			*1 2660		0 1145	0 0711	Moon S. declination a max. = 21° 41' N.E. breeze.	
		71	53		0 2280				
1 8294	18			0 8697		0 1293	0 0935	N.E. breeze	31
		62	52		0 0690			Gentle N.E. breeze, rain.	
1 6714	10			1 1897		0 1050	0 1580		
		81	50		0 1210			Stiff S.W. breeze, rain.	
1 5775	31			0 7740		0 1509	0 0939	do do fair.	32
		73	61		0 0870			Gentle do do	
1 4675	12			1 1500		0 2276	0 1100	Very feeble S.W. breeze—fine clear weather.	
		78	76		0 2580			Light N.W. breeze do	
1 3458	2			0 3960		0 2888	0 1217	S.W. breeze do	33
		89	92		0 1980			Gentle N.W. breeze—fine	
1 2540	3			1 0410		0 2909	0 0878	Maximum diurnal inequality observed in low water levels = 0 296 ft. Gentle S.W. breeze, fine.	
		107	86		0 2960			Feeble N.E. breeze—fine	
1 0938	21			0 3470		0 1901	0 1642	Very light N.E. breeze—fine	34
		83	52		0 0800			S. breeze—raining weather.	
1 0833	31			0 7420		0 0802	0 0105	N.E. breeze rain	
		77	50		0 2900			Feeble N.E. wind, sky overcast. Moon's last quarter (Quebec) June 1st from 7.53 a.m.	
1 2025	27			0 6750		0 1389	0 1192	Sky overcast—feeble N.E. wind.	35
		89	80		0 0470			Light N. breeze	
1 0828	9			0 8050		0 2179	0 1197	Feeble N.E. breeze—fine	
		76	68		0 2690			Light N.W. breeze fine	
0 9813	8			0 1760		0 3288	0 1015	Feeble N. breeze—light rain	36
		42	56		0 2870			do rain	
0 9690	14			0 3610		0 2050	0 0133	Light N.W. wind—fine.	
		56	49		0 1100				
	7			0 0510					
19 4902	215	1068	906	10 9054	2 5300	2 4749	1 3063		
1 3921	14	76	71	0 7270	0 1687	0 1768	0 0933		
72 6987	1072	3463	3183	28 8384	8 8650	7 7889	4 5481		
1 2754	19	59	56	0 5059	0 1555	0 1391	0 0812		



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## APPENDIX 13.

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### TIDAL FLUCTUATIONS, ETC., CHAMPLAIN.

DURING A COMPLETE LUNAR MONTH OF THE HIGH WATER SEASON  
OF 1888, VIZ., MAY 2, TO JUNE 1.

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### TABLE XVI.

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WEEKLY SERIES OF GAINING AND LOSING  
TIDES, Nos. V, VI, VII, AND VIII.

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## APPENDIX 13.

TABLE XVI.—Tidal Fluctuations at Champlain during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

[illegible]

## APPENDIX 13.

TABLE XVI.—Tidal Fluctuations at Champlain during the High water season of 1888, viz. :—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																			
Gauge book reference numbers. Series VI. Losing tides.	High and low waters observed each civil day.	Time, Eastern Standard.		Duration of floods.		Duration of ebbs.		Length of half tide day H.W. to H.W.		Priming—or lagging + of tides		Elevations of summits and troughs of fluvial tide waves.		Ranges of floods.	Ranges of ebbs.	Mean tide levels corrected for diurnal inequalities.	Mean amplitudes corrected for diurnal inequalities.	In duration of floods.	In duration of ebbs.
		H. M. A.M. OF P.M.		H. M.		H. M.		H. M.		Min Min		Feet. Feet.							
		H.	M.	H.	M.	H.	M.	H.	M.	Min	Min	Feet.	Feet.						
16	May 12 L.W.	7	40	A.M.							-20		22 40						
	May 12 H.W.	11	0	A.M.	3	20		8	40	12 47	-23	35	24 05	1 65		23 22	1 28	47	2
	do 12 L.W.	7	40	P.M.								118	22 75		1 30				
	do 12 H.W.	11	47	P.M.	4	7						53	23 99	1 24		23 62	1 24	47	12
17	do 13 L.W.	8	5	A.M.				8	18	11 48		50	23 25		74			37	15
	do 13 H.W.	11	35	A.M.	3	30					* 42	28	24 92	1 67		24 07	1 09	17	15
	do 13 L.W.	8	8	P.M.				8	33	12 20		38	23 80		1 12			17	15
	do 14 H.W.	11	55	P.M.	3	47		8	48	11 53		76	24 60	80		24 37	1 06	42	15
18	do 14 L.W.	8	43	A.M.								25	23 87		73			42	15
	do 14 H.W.	11	48	A.M.	3	5					-22	37	25 43	1 56		25 64	1 04	44	15
	do 14 L.W.	9	40	P.M.				9	52	12 35		30	24 36		1 07		42	15	
	do 15 H.W.	12	23	A.M.	2	43						27	25 12	76		24 97	86	30	15
19	do 15 L.W.	9	45	A.M.				9	22	12 42		35	24 71		41			37	15
	do 15 H.W.	1	5	P.M.	3	20					+17	23	25 87	1 16		25 19	81	35	15
	do 15 L.W.	9	32	P.M.				8	27	12 25		56	24 85		1 02		38	15	
	do 16 H.W.	1	30	A.M.	3	58						64	25 50	65		25 27	85	25	15
20	do 16 L.W.	9	30	A.M.				8	0	12 8		45	24 87		63			10	
	do 16 H.W.	1	38	P.M.	4	8					-2	95	25 77	90		25 29	74	27	15
	do 16 L.W.	10	50	P.M.				9	12	12 40		80	24 97		80			4	
	do 17 H.W.	2	18	A.M.	3	28		8	5	12 27		75	25 61	64		25 31	70	25	15
21	do 17 L.W.	10	23	A.M.							+5	77	24 93		68			54	15
	do 17 H.W.	2	45	P.M.	4	22						97	25 62	69		25 30	63	80	15
	do 17 L.W.	12	15	A.M.				9	30	12 28		72	24 83		79			84	
	do 18 H.W.	3	13	A.M.	2	58						75	25 17	84		25 07	58	70	15
22	do 18 L.W.	11	33	A.M.				8	20	12 20		50	24 73		44			62	15
	do 18 H.W.	3	33	P.M.	4	0					-5	45	25 47	74		24 97	53	72	15
	do 19 L.W.	1	5	A.M.				9	32	12 25		45	24 67		80			67	15
	do 19 H.W.	3	58	A.M.	2	53						50	24 81	14		24 91	48	3	15
23	do 19 L.W.	12	53	P.M.				8	55	12 52		60	24 66		15			64	
	do 19 H.W.	4	50	P.M.	3	57					* 52	40	25 47	81		24 96	52	15	
Totals 15 tides.		H.W. 95 18		55 36		121 34		178 50		+74 820		377 40		13 75	10 68	371 06	12 41	621 66	
		L.W. 190 2 +12								-94 781		363 65							
		142 2																	
Means		15 H.W.								+25 55		25 16		0 92	0 76	24 74	0 53	44 44	
		do																	
		14 L.W.								-19 56		24 24							

N.B. Maxima in whole lunar month indicated by a star, thus : \*, and minima by a circle, thus : °.

†Maximum diurnal inequality in low water levels—observed = 0 55 ft.

‡Moon's N. declination a maximum = 27° 8'.

§Moon's first quarter (Quebec), May 18th, from 6h. 65m., p.m.

## APPENDIX 13.

TABLE XVI.—Tidal Fluctuations at Champlain during the High water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued.)						RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."														
Diurnal Inequalities.					Lunital intervals.	Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.									Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)	Length of half tide day H. W. to H. L.	Priming—or lagging + of tides	Lunital intervals.	General coefficients of semi-amplitudes from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.	Series VI. Losing tides. Gauge book reference numbers.
In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.		Upper passage.			Lower passage.			Ages, etc.								
Min.	Feet.	Feet.	Feet.	Feet.		H.	M.	Days.	H.	M.	H.	M.	H.	M.						
57		0 35			10	18								19						
59	0 06		0 40	0 04	10	41				12 42	1 6		11 29	19	10 47		82			
39		0 50			10				1 6				11 45		10 39		82			
32	0 93		0 45	0 15	10	6				1 29			12 15	19	10 31		81			
27	0 32	0 56	0 30	0 03	10	2			1 53				12 16		10 23		80			
42	0 83		0 27	0 02	9	30				2 18			12 32	18	10 14		78			
7	0 31	0 49	0 33	0 18	9	40			2 43				12 48		10 5		76			
17	0 75	0 35	0 22	0 05	9	57				3 8			1 4	16	9 56		73			
17	0 37	0 14	0 08	0 04	9	57				3 8			12 18		9 49		70			
32	0 27	0 02	0 02	0 11	9	39			3 33				1 22							
		0 10			9					3 59			12 18	13	9 41		66			
13	0 16	0 10	0 02	0 04	9	54				5 6			1 40		9 35		62			
		0 04			9				4 24				12 19							
1	0 01		0 11	0 07	9	55							12 22	4	9 31		58			
		0 10			9					4 50			2 21							
8	0 45	0 10	0 13	0 05	9	58				6 6			12 24		9 30		54			
		0 30			9				5 15				2 45							
5	0 66	0 06	0 10	0 05	9	52				5 41			12 26		9 30		51			
		0 06			9					7 6			3 11	6						
27	0 66	0 01	0 05	0 05	9	52			6 6				12 30		9 35		48			
					9								12 34							
2			0 05	0 04	10	18				6 32	8 6		4 15	22	9 43		46			
356	6 08	2 88	2 54	0 02	149	39	25	0	40 39			95	8 172 46	+28	149 29		1007			
									84 0			108 0		-89						
									124 39			203 8								
24	0 43	0 21	0 18	0 07	9	59	3	34	15 35			13 33	12 20	+14	9 58	67 13				
														-15						



## APPENDIX 13.

TABLE XVI.—Tidal Fluctuations at Champlain during the Low water season of 1888, viz.:—from quadrature, May 2nd, to quadrature, June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).							RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MAREES."										
Diurnal Inequalities.							Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon.										
In duration of ebb.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.	Lunital intervals.	Upper passage.	Lower passage.	Ages, etc.	Eastern standard civil times of high water at Quebec, based on Brest times: (No. 2.)	Length of half tide day H. W. to H. W.	Priming— or lagging + of tides	Lunital intervals.	General coefficients of semi-amplitudes from "L'Annuaire des Mares," corresponding to observed tides assumed to be 48 hours old.			
Min.	Min.	Feet.	Feet.	Feet.	Feet.	H. M.	H. M.	H. M.	Days.	H. M.	H. M.	Min.	H. M.				
			0 07									+ 22					
30	20	0 37	0 13	04	01	10 43	6 57		9 6	4 53	12 38		9 56	46		23	
40	12	0 10	0 20		01	10 47		7 23		5 33	12 40		10 10	48			
42	7	0 10	0 07	09	08	10 40	7 48		10 6	6 12	12 39	+ 29	10 24	51		24	
0	15	0 07	0 18	07	13	10 39		8 14		6 49	12 37		10 35	56			
3	8	0 02	0 02	04	07	10 53	8 40		11 6	7 23	12 34	+ 21	10 43	62		25	
13	14	0 08	0 04	04	04	10 58		9 07		7 54	12 31		10 47	69			
18	32	0 33	0 00	03	14	10 49	9 34		12 6	8 22	12 28		10 48	76		26	
5	5	0 10	0 03	06	11	11 12		10 1		8 48	12 26		10 47	83			
7	33	0 35	0 07	07	06	10 39	10 29		13 6	9 13	12 25	- 1	10 44	89		27	
2	22	0 20	0 04	04	11	10 32		10 58		9 37	12 24		10 44	95			
40	40	0 40	0 07	01	08	10 32	11 27				12 24	2	10 39	95			
		0 02				10 3				10 1	12 24		10 34	100		28	
60	60	0 35	0 02	02	11	10 13		11 57	14 6	10 25	12 24		10 28	104			
70	100	0 51	0 08	01	04	9 22	12 28		15 6	10 48	12 23		10 20	106		29	
20	100	0 64	0 13	01	01	10 12		12 58		11 11	12 23		10 13	107			
410	468	3 62	1 08	0 70	1 00	147 42	67 23	70 38		117 9	174 56	5	147 8	1092			
										168 0		63					
										285 9							
20	33	0 26	0 08	0 05	0 07	10 33	9 38	10 5		20 22	12 30		10 31	78 00			
												12					
												2					

Series VII. Gauging tides.  
Gauge book reference numbers.

## APPENDIX 13.

TABLE XVI.—Tidal Fluctuations at Champlain during High water season of 1888.  
viz., from quadrature of May 2nd to quadrature of June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS, &c.																							
High and low waters observed each civil day.			Time Eastern Standard.	Duration of floods.		Duration of ebbs.		Length of half tide-day H.W. to H.W.		Priming or lagging + of tides.		Duration of apparent stand within 0.05 feet.		Elevations of summits and troughs of fluvial tide waves.		Ranges of floods.		Ranges of ebbs.		Mean tide levels corrected for diurnal inequalities.		Mean amplitudes corrected for diurnal inequalities.	
H.	M.	A.M. P.M.		H.	M.	H.	M.	H.	M.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.		
May 28 M.																							
11	10	P.M.								10													

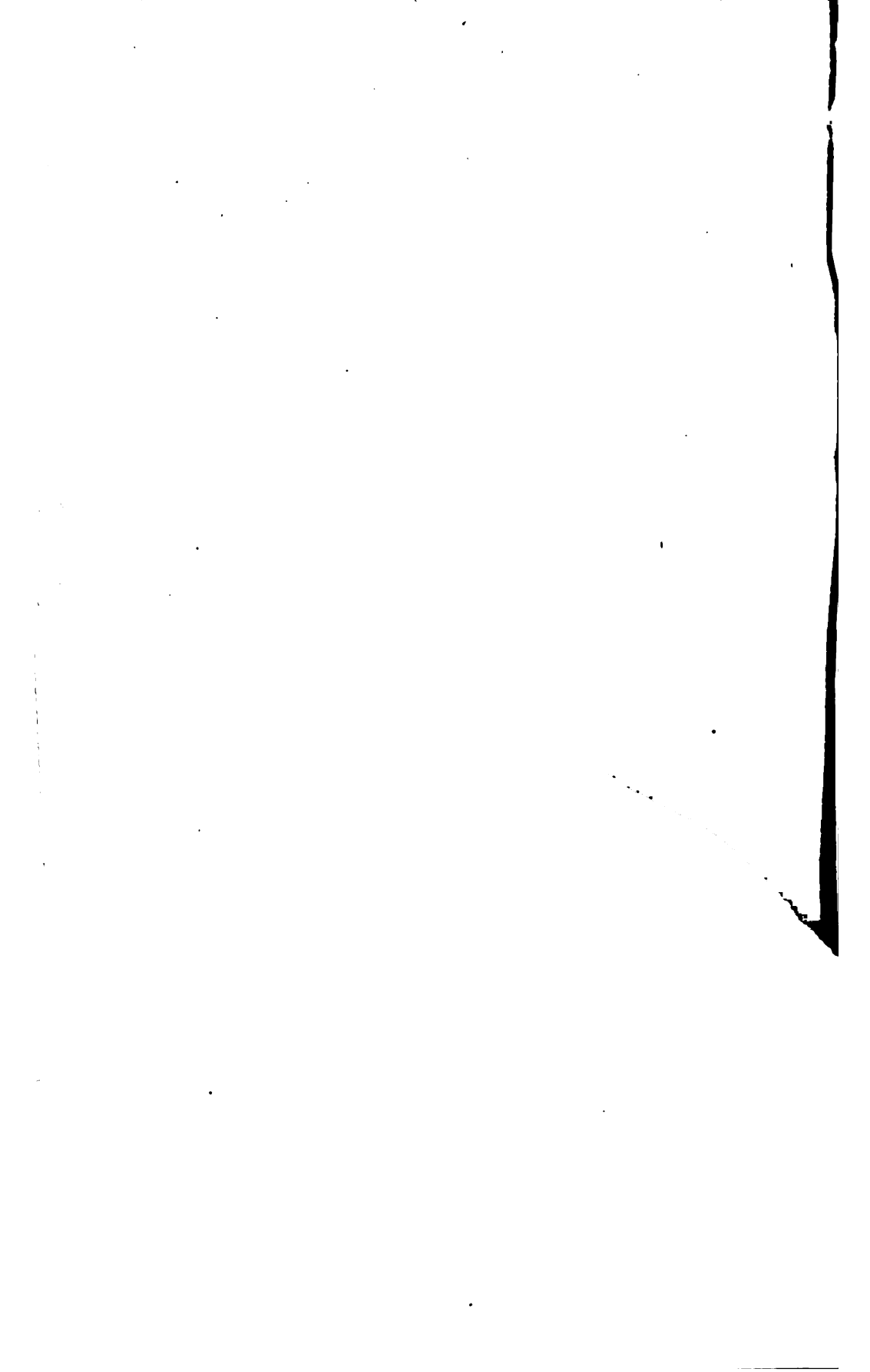
## APPENDIX 13.

TABLE XVI.—Tidal Fluctuations at Champlain during High water season of 1888, viz., from quadrature of May 2nd to quadrature of June 1st.

DIRECT RESULTS OF TIDAL OBSERVATIONS— (Continued).										RESULTS BASED ON DATA FROM NAUTICAL ALMANAC AND "L'ANNUAIRE DES MARÉES."									
Diurnal Inequalities.										Eastern standard civil times of meridian passages immediately preceding observed high waters, with corresponding ages and phases of the moon. Eastern standard civil times of high water at Quebec, based on Brest times : (No. 2.) Length of half tide day H. W. to H. W. Priming—or lagging + of tides Lunital intervals. General coefficients of semi-amplitude from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old. (Gauge book reference numbers. Series VIII. Losing tides.)									
In duration of floods.	In duration of ebbs.	In semi-tide days.	In high water levels.	In low water levels.	In mean tide levels.	In amplitudes.	Lunital intervals.		Upper passage.	Lower passage.	Ages, etc.	Eastern standard civil times of high water at Quebec, based on Brest times : (No. 2.)		Length of half tide day H. W. to H. W.	Priming—or lagging + of tides	Lunital intervals.		General coefficients of semi-amplitude from "l'Annuaire des Marées," corresponding to observed tides assumed to be 48 hours old.	
Min.	Min.	Min.	Feet.	Feet.	Feet.	Feet.	H.	M.	H.	M.	H.	M.	H.	M.	Min.	H.	M.		
20			75	16	02	01									+ 3				
32	73	106	96	12	09	06	9	21	1	29		11	35	12 24		9	59	106	30
24	93	117	73	23	10	02	10	16			1 59	16	6	12 23	3	9	59	104	
16	100	84	96	05	09	13	9	13	2	30		12	22	12 24		9	52	101	31
18	60	42	56	12	18	03	9	36			2 50	12	46	12 23	3	9	47	96	
35	93	58	91	20	22	05	9	17	3	28		1	9	12 23		9	41	91	32
17	91	74	25	20	25	12	9	58			3 55	13	32	12 24	3	9	37	85	
12	84	72	83	18	26	08	9	25	4	22		1	56	12 26		9	34	79	33
60	114	54	20	26	24	04	10	5			4 48	2	22	12 26	+ 2	9	34	72	
10	73	63	62	17	12	03	9	52	5	13		2	48	12 27		9	35	66	34
30	125	96	55	03	05	01	10	43			5 37	3	15	12 30	+ 7	9	38	60	
82	140	58	70	10	24	07	10	0	6	0		3	45	12 32		9	45	55	35
55	63	8	21	30	29	11	10	15			6 23	4	17	12 35	+ 17	9	54	51	
45	0	45	30	17	20	05	10	23	6	45		4	52	12 31		10	7	48	36
21	47	68	05	18			11	17			7 6	5	23	12 29	+ 10	10	17	46	
											23 6								
47	1156	943	8 58	2 47	2 35	0 80	139	41	29	47	32	47	80	0 186	41	+ 36			
													+ 120	0		9			
													= 200	0					
32	83	67	0 57	0 16	0 17	0 06	9	59	4	15	4	41	14	17	12 27	+ 9	9	49	75
															3				
1729	2016	2415	22 35	8 56	8 07	3 46	594	56	193	26	296	50	816	16	707	42	+ 178	589	53
																	164		
30	49	42	0 39	0 15	0 14	0 06	10	26	6	55	10	14	14	19	12 25	+ 14	10	21	71
																10			

\* Moon's last quarter (Quebec) June 1st, from 7h. 53m. a.m.

Maximum diurnal inequality in low water levels observed = 0 30 ft.



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**APPENDIX No. 14.**

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REPORT ON WATER LEVELS, RIVER ST. LAWRENCE, BETWEEN QUEBEC, MONTREAL AND  
LACHINE, BY R. STECKEL, CIVIL ENGINEER, 24TH NOVEMBER, 1891.

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**EXTRACT FROM A REPORT**  
**DATED 10TH OCTOBER, 1887, ON**  
**FLUCTUATIONS IN THE LEVEL OF LAKE CHAMPLAIN**  
**AND AVERAGE**  
**HEIGHT OF ITS SURFACE ABOVE THE SEA,**

BY

**ASSISTANT C. A. SCHOTT,**

*of the United States Coast and Geodetic Survey.*

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EXTRACT FROM A REPORT  
DATED 10th OCTOBER, 1887, ON  
FLUCTUATIONS IN THE LEVEL OF LAKE CHAMPLAIN  
AND AVERAGE  
HEIGHT OF ITS SURFACE ABOVE THE SEA,

BY  
ASSISTANT C. A. SCHOTT,  
*of the United States Coast and Geodetic Survey.*

\* \* \* \* \*  
THE ABSOLUTE HEIGHT OF THE LAKE ABOVE THE OCEAN.

The absolute height of Lake Champlain when in an average state, as measured by the water gauge at Fort Montgomery between 1871 and 1882, may now be closely approximated. The following data are available for this purpose. Bench mark on grist mill at Greenbush, opposite Albany, N.Y., above half tide or average level of the ocean 4.489 m. or 14.73 ft.

This result depends on tidal observations in New York harbor, made by the Coast Survey at Governor's Island, between 1852 and 1879 inclusive (comprising therefore one and a half revolutions of the moon's nodes), and on spirit levelling along the eastern side of the Hudson River, by J. B. Vose in 1857-8\* and resumed by O. H. Tittman in 1887.

This same bench mark was the starting point (level) for the determination of the heights of the great lakes.—Prof. Paper's C. of Eng. No. 24, p. 608.

In 1882, Asst. Tittman resumed the levelling operations for the connection of Albany with the lake; the line started from Albany at lock No. 1 of the Erie Canal, the height of which he had determined in 1877, viz.; mitre sill at south-east gate of lock above mean sea level, 1.873 m. or 6.145 ft. He then followed the tow-path of the Champlain Canal to Whitehall, N.Y., and thence carried the line along the track of the Delaware and Hudson Canal Co.'s R. R., as far as Putnam Station. There a water gauge and mark was established and connected with others placed at Port Henry, Plattsburg, Burlington and Rouse's Point. He makes bench mark No. 40, cut in the R. R. culvert at Putnam, to be 32.536 m. above bench mark at lock No. 1, the absolute height of No. 40 is therefore 30.663 m. and the zero of his water gauge 30.048 m., the latter being 0.615 m. below this mark. Simultaneous observations were made by means of these gauges of the stage of the lake surface for 15 consecutive days, 4th to 19th November, at the hours 8 a.m., noon and 5 p.m.

The zero of each gauge was referred to a permanent bench-mark established near it. These gauges were each 4 ft. long and graduated from top downward.

We have: mean water level, 4th to 18th November, 1882, corresponds to reading 0.995 m. on the Putnam gauge, this mean level therefore is 29.053 m. above the ocean and corresponds to the reading 0.843 m. of the Rouse's Point gauge.

\*The zero of gauge at Governor's Island was transferred to mark on Hudson River, foot of 18th street, New York City, by water level.

This places the zero of the Rouse's Point gauge 29·896 m. above the ocean, and since the *Rouse's Point bench-mark* on Chapman's block, north side, is 3·649 m. above it, the latter is 33·545 m. or 110·06 feet above the *mean sea level*. This mark has been proposed for an international bench-mark for the connection of the American and Canadian spirit levels in this region.

According to Asst. Tittman, the Chapman block bench-mark is 1·350 m. above the level of the heel of loophole of Bastion A, Fort Montgomery which is also known as the hydrographic bench-mark of the fort, and this hydrographic mark is 2·925 m. above the U.S. Engineer's bench-mark which is the level of base course of scarp wall of bastion \*B; the latter is therefore 29·270 m. above the mean sea level.

The zero of the Engineer's water gauge being one and a half foot below this mark and the average readings of the water level between 1871 and 1882 (*vide* preceding table) being 2·64 feet, we have, finally, the height of the average lake level above the mean sea level 29·618 m. or 97·17 ft.

Pending spirit levelling between the Putnam and the Rouse's Point marks and further observations of the lake level for a series of years, this result may be accepted as a close approximation to the true value. I estimate its probable error or uncertainty at about 0·3 feet (exclusive of uncertainty due to secular change.)

We can now also determine the height above the ocean (meantide) of the level of reference adopted on the Coast Survey charts of the lake; this level has reference to a gauge and mark at Plattsburg, and computation shows that the chart plan very nearly corresponded to the zero of the Engineers' gauge at Fort Montgomery (was about 0·02 m. above it); this plan of references consequently is very nearly 28·93 or 94·6 ft. above the mean level of the Atlantic, and is also 0·78 m. or 2·56 ft. below the average level of the lake, period 1871-1882. \* \* \* \*

#### B. M. AT ROUSE'S POINT, N.Y., O. H. TITTMAN, 1882.

The water gauge was nailed against the dock opposite Chapman's block at Rouse's Point. The bench-mark is a cross and circle ⊕ cut with a chisel into the stone water sill of Chapman's block on the north side of the building and about 15 ft. from the north-east corner, as shown on the sketch sent with the extract. This B. M. was connected with the hydrographic bench-mark at Fort Montgomery. The hydrographic bench is the heel of the loop-hole of Bastion A. The B. M. at Rouse's Point is 3·6487 m. above zero of gauge.

#### FORT MONTGOMERY.

The zero of water levels at Fort Montgomery is 1· $\frac{5}{10}$  ft. below top of base course of scarp wall, at the left re-entrant angle of Bastion B., at the outer end of the lake postern.

\*This same level is designated by Assistant Tittman "water sill level at the fort."



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## APPENDIX No. 15.

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REPORT OF WATER LEVELS, RIVER ST. LAWRENCE, BETWEEN QUEBEC, MONTREAL AND  
LACHINE, BY R. SEECKEL, CIVIL ENGINEER, 24TH NOVEMBER, 1881.

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# PROGRESS REPORT, R. STECKEL

TO

## CHIEF ENGINEER OF PUBLIC WORKS,

9TH DECEMBER, 1886,

ON PRECISION LEVELLING CARRIED OUT IN 1885-86, WITH A VIEW OF ESTABLISH-  
ING THE HEIGHTS OF THE FINISHED COPINGS OF THE GRAVING DOCK AT  
ST. JOSEPH DE LÉVIS AND THE LOUISE EMBANKMENT, AT QUEBEC,  
ABOVE THE ZERO OF THE ORIGINAL STANDARD TIDE-GAUGE  
PUT UP BY THE QUEBEC HARBOUR COMMISSIONERS  
AT POINTE À CARCY.

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# GEODETIC LEVELLING, RIVER ST. LAWRENCE.

## PROGRESS REPORT.

DEPARTMENT OF PUBLIC WORKS,  
OTTAWA, 9th December, 1886.

H. F. PERLEY, Esq., Chief Engineer.

SIR,—To comply with instructions received from you, I now beg to submit the following progress report on the geodetic levelling which has been carried on under my charge since 1885, referring more particularly to the operations performed with a view of establishing the actual heights of the finished copings of the Lévis Graving Dock and Louise Embankment at Quebec, above the 0 of the original standard gauge of the Quebec Harbour Commissioners.

The gauge here referred to is that put up by Mr. Simmons, a former engineer of the Quebec Harbour Commissioners, on the south side of their Pointe à Carcy wharf, several years previous to the letting of the extensive harbour works now in course of construction at Quebec and Lévis.

The correct determination of the relative elevation of the points mentioned, obviously involved the connecting of a series of levels taken on the north shore, with another series run along the south shore of the St. Lawrence, which river is from  $\frac{3}{4}$  to 1 mile wide opposite the City of Quebec. This connection could be effected: 1° By measuring simultaneously, on a calm day, the heights of at least two fixed points directly opposite each other on the river shore, above the water surface while quite smooth and in a perfect state of equilibrium, say at high or low tide, or about the time of slack water, or else: 2° by sighting in very clear weather the whole way across the river to targets put up on firm ground at suitable places near high water mark: care being taken to place the instrument sufficiently high over the water for the line of collimation to clear the densest of the vapors which continually emanate therefrom, and further, to make the pointings only when the portion of the atmosphere traversed, would be quite free of smoke from steamboat or factory chimneys or other sources.

These modes of carrying the levels across the comparatively wide estuary of the St. Lawrence, it is easily seen, are both attended with difficulties and each has its drawbacks. Having but one geodetic level at my disposal in 1885, I concluded, that all things considered, it would be best to take advantage of the complete covering of the river surface in winter, by a crust of ice several feet thick, over which, though it be incessantly rising or falling with the tide, the levels can be satisfactorily carried from shore to shore in one sight: there being in such case no vapors to interfere with the free passage of the luminous rays through the atmosphere, necessitating objectionable corrections for excessive refraction, etc.

Moreover, in order to reduce the chances of making errors of pointing, etc., to a minimum, I further decided, with your approval, to effect the crossing on the contracted part of the St. Lawrence tide-way between the mouth of the Chaudière River and Cap Rouge, some seven miles west of the River St. Charles, where the distance between the high water marks on opposite shores is less than one-half mile, and where the winter road kept open every year across the ice, affords an easy and rapid means of communication from one shore to the other.

This course necessitated the levelling of seven miles on the north shore down to the Louise Dock, in a direction nearly parallel to that of the projected continuous line to be run on the south shore of the St. Lawrence.

During the last days of March, 1885, I made several attempts to level westward along the north shore from a bench-mark (B) made at the base of the cliff, near Chamber's Cove, above Victoria Cove, to another bench (A) made on the rock, near the point selected for sighting across the ice, to the foot of Basile's Hill. Owing, however, to persistent unfavourable weather for nearly a whole week, and the time at my disposal for this work being unavoidably limited, I had to leave Quebec after having succeeded in completing, on the 3rd April, only one set of observations, viz., that from the north to the south side of the tide-way.

The atmosphere was quite clear and calm, while the observations just referred to, were made, and the distance from level on north shore to rod on south shore was measured twice on the ice with a correct tape line; being found to be 2,852 ft.

As to refraction, I adopted the value of the coefficient  $n$  given by the celebrated Russian astronomer Struve, for valleys, viz., 0.085 ft. instead of that used for general geodetic levelling purposes (0.0625 ft.), so that the correction applied for curvature and refraction to the reading across the river was calculated by the formula:—

$$n = \frac{d^2}{2r} (1 - 0.17) = \frac{.83d^2}{41.794 \cdot 000} = 0.000\cdot000\cdot020 d^2 \text{ instead of } 0.000\cdot000\cdot021 d^2 \text{ in}$$

feet, where  $r$  denotes the radius of the great circle of the earth in the plane in which the observations are made, and  $d$  the distance, level to rod in feet.

The results of the computations made in connection with the winter operations of 1885, went to show that the coping of the Louise embankment stands 24.038 ft. above the 0 of the Quebec Harbour Commissioners' old gauge, south side of Pointe à Carcy wharf and the coping of the Graving Dock, Lévis, with top at a mean height of 24.14 ft. above the same zero, or say 0.1 ft. higher than that at Quebec.

Now, besides the heights of the bench-marks, copings, gauges, etc.; the elevations of the high and low water surfaces of some flowing and ebbing tides had also been established in 1885 at several points on both sides of the estuary, from the Lévis Graving Dock westward up to Basile's Hill.

Upon examining the geometrical loci of the summits and troughs of the fluvial tide waves thus determined, I found that all these curves pointed to the existence of a greater rise in the stream at high and low tide going from the Quebec Harbour Commissioners' Pointe à Carcy wharf to the Graving Dock at St. Joseph de Lévis, than that which was shown to have taken place from Victoria Cove, opposite the narrow gorge through which the outflowing streams of tide and drainage water rushes with great force, to the said wharf at Pointe à Carcy. I was aware, of course, that being unprovided with special boxed-in gauging apparatuses with pointers and verniers, and owing to the swells raised by steamships and other craft, etc., it could not be expected that the observed elevations of the water surface would be absolutely correct, still, as a rise however small in the water level in the locality referred to, could not well be accounted for, I became apprehensive, lest the connection of the regular permanent bench-mark (LXV.) on the south shore, near high water mark, with the turning point established here on solid ground for use in levelling across the river, was imperfectly made, on account of the operations having had to be done on soft snow and ice across a gully or bay wherein the tide might have been at work unnoticed.

Under the circumstances I considered it prudent to suggest, as you are aware, the desirability of checking the results of the winter crossing by means of simultaneous observations from both shores, with two good instruments placed as nearly as practicable, so that their lines of collimation would traverse the same strata of air, when sighting across the water. With your sanction, a second geodetic or precision level was ordered from Messrs. Fauth & Co., and in July last the levels were successfully crossed over the St. Lawrence at two points, viz., at Basile's Hill and at the Queen's wharf, opposite Quebec city.

The close agreement of the results afforded by these crossings in connection with the land levelling leaves now no room for doubting the accuracy of both the field operations and office computations performed; the figures will prove more convincing than any words I might venture to add in their support.

In the annexed abstracts of results the elevations are all referred to the approximate mean level of the Atlantic Ocean, as determined by me at Quebec in 1882, taking as a basis the tidal observations made at this port under my directions in 1876, 1880 and 1881, this datum\* is 9.76 ft. below the mean tide level adopted by the Royal Engineers in 1864 for their contoured plan of Quebec and environs.

It may not be out of place to bring to your notice, in this connection, the propriety of having put up in a permanent manner at least one self-registering tide gauge, of approved construction, on the Atlantic coast, and another on the Pacific coast, with the main object in view of making accurate determinations of the mean level of the sea in Canadian waters. The cost of attending regularly to these gauges, if properly located, would be comparatively small.

There are at present in the United States four permanent tide stations, viz., two on the Atlantic and two on the Pacific coast, besides many temporary ones where self-registering apparatus are used.

Pending the establishment of similar stations on Canadian territory, our system of geodetic levels should be connected with that of the United States C. and G. Survey, at one or more convenient points, in which case the mean sea level as deduced from the tidal observations made at the North Haven station in Maine, or the Sandy Hook, N.Y., station, could be adopted as a plane of reference in lieu of the approximate sea level now used temporarily as the best available rational datum. By referring to the abstracts appended hereto, it will be seen that the land operations performed between the Louise embankment at Quebec and the Lévis Graving Dock afford the following results when taken in connection with the crossing made in July, 1886, at the contracted part of the river, opposite Basile's Hill, viz. :—

	Elevation above * datum.	Elevation above 0 of Q. H. C. gauge, south side Pointe à Carcy wharf.
	Feet.	Feet.
1. Top of coping Louise embankment, near junction with timber break-water.	26 0177	24 038
2. 0 of Quebec Harbour Commissioners gauge, north side of Pointe à Carcy wharf.	8 0585	10 038
3. Lower stone step of rear entrance to Quebec Custom House, found in 1877-78 to be 22.73 ft. above 0 of south side gauge.	24 6531	22 674
4. Coping of Graving Dock, Lévis, mean between elevations of north and south ends.	25 8357	23 856
5. 0 of gauge at Graving Dock, 11th Oct., 1885.	0 6389	1 341
6. Nail driven by Kiniple & Morris into elm tree on north-east side of dock, 1875.	24 7161	22 737
<i>Fluvial tide wave, 12th October, 1885.</i>		
1. Summit of high water, 9 a.m.—		
(a.) At Graving Dock, Lévis.	15 779	
(b.) At Quebec Harbour Commissioners gauge, south side Pointe à Carcy wharf.	15 929	
(c.) Rocketts upper wharf, Victoria Cove.	15 848	
2. Bottom of trough at dead low water, about 4.20 p.m.—		
(a.) At Graving Dock.	2 289	
(b.) Pointe à Carcy.	2 404	
(c.) Victoria Cove.	2 248	
3. Summit at Harbour Works, about 9.05 p.m.—		
(a.) At Graving Dock.	17 589	
(b.) At Pointe à Carcy.	17 704	
(c.) Victoria Cove.	17 348	

\* The datum plane here referred to is 2 ft. below that subsequently adopted for reasons set forth at length in Note A, Appendix No. 21 to this Report.

These elevations of the high and low water levels of the incoming and outgoing tide waves, indicate that at these extreme stages of the river, there was a rise of from 0·08 ft. to 0·36 ft. in the surface from Victoria Cove to Pointe à Carcy and thence to the Graving Dock, a fall instead of a rise as per winter crossing.

The following are the mean and probable errors by which the results of the 18·53 miles of land levelling performed between the Louise embankment and the Graving Dock, are effected as found by actual computation, viz :—

	Feet.
1. Mean error for whole distance.....	0·0373
2. Probable error for whole distance.....	0·0252
3. Mean error per mile.....	0·0086
4. Probable error per mile.....	0·0058

It will be seen by referring to pages 5½, 6, 16 and 17 of the Appendix, that by applying in all the computations the usual corrections for curvature, refraction and irregularity of collars, instead of assuming that the corrections required for the back-sights are exactly compensated for by those of the fore-sight, or *vice versa*, which is truly the case for simultaneous observations made in opposite directions at equal altitudes the difference which obtains is for the upper crossing at Basile's Hill but 0·0019 feet and for the lower crossing at Queen's Wharf only 0·0037 feet.

I may here remark that after the river crossing were completed, the irregularities of the collars as well as the mean value of a division of the micrometer head, were carefully determined for the new level (No. 2) and found to correspond respectively to 0·014 micrometer division and 2·22 seconds, the inequality of the collars was also tested anew for level No. 1 and found to correspond to + 1·1 micrometer division.

C  
By crossing directly from B. M on the Queen's store on Champlain St., Quebec, to  
H

C  
B. M. at the foot of Couture's Hill, Lévis, and proceeding to the Graving Dock the  
LXXI

mean elevation of the coping of the latter is found to be 25·8365 ft. ; or only 0·0008 ft.

C  
greater than that obtained by connecting B. M. with the crossing at Basile's Hill along  
H  
the north shore and coming down on the south shore to the dock.

Moreover, the maximum variation of the difference of level between the outside plates on the opposite shores derived from a single set of corrected observations, from the mean results of the four sets with corrections omitted is 0·0342 ft. for the upper or Basile's Hill crossing and 0·0497 ft. for the lower or Queen's wharf crossing (see pages 5½, 6, 16 and 17, Appendix).

In the short season of 1885, August to October, besides connecting the Basile's Hill crossing with the Louise embankment, Quebec, the proposed continuous line of levellings along the St. Lawrence was run on the south shore from the Lévis Graving Dock up to Pointe Platon; section No. 5 being levelled going eastward from St. Antoine to St. Joseph de Lévis, and 12 miles of section No. 6 run from St. Antoine westwardly. The total distance levelled over in 1885 was 51·35 miles, the computations have all been performed for this distance, and the season's work proven to come up to the generally accepted standard of accuracy.

In 1886, the gaps which remained in the continuous line between Pointe Platon and La Baie have been filled in by the completion of two and a-half intermediate sections, viz : the upper half of section No. 6 westwardly from Pointe Platon to St. Jean des Chaillons, section No. 7 westwardly from Bécancour to La Baie du Fèbvre and section No. 8 eastwardly from Bécancour to St. Jean des Chaillons, so that the continuous levelling on the south shore is now completed up to a point about 4 miles west of Sorel.

In addition to the observations just referred to, levels have also been taken from Chambly to Longueuil, on the post road, with a view of connecting the system along the Richelieu with that proposed to be carried out along the St. Lawrence, for verification purposes.

The total distance levelled over, July to November, 1886, is about 80 miles ; besides the levelling operations that have been performed, the elevations of the river surfaces at various stages have also been observed at several places and recorded.

The office computations required in connection with the field work done in 1886 are now being proceeded with in the usual manner.

I have the honour to be, sir,

Your obedient servant,

(Signed) R. STECKEL

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## APPENDIX No. 16.

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REPORT ON WATER LEVELS, RIVER ST. LAWRENCE, BETWEEN QUEBEC, MONTREAL AND  
LACHINE, BY R. STECKEL, CIVIL ENGINEER, 24TH NOVEMBER, 1891.

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### ACCOUNTS

SHOWING THE

GREAT DAMAGE DONE TO SHIPPING

AND OTHER PROPERTY IN THE

MARITIME PORTION OF THE ST. LAWRENCE

BY

HIGH SPRING TIDES

DRIVEN UP THE ESTUARY BY NORTH-EASTERLY STORMS IN 1873  
AND 1884.

*From the Quebec Morning Chronicle of 31st March, 1873, and 5th and 6th November, 1884.*

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QUEBEC, 31st March, 1873.

#### HIGH TIDES.

Yesterday morning under the influence of the spring tides, the river rose to an extraordinary height, overflowing the wharves and flooding the cellars of the houses in the lower portion of the city.

The ice was lifted above the level of the wharves and 8 inches of water covered the Finlay market. In St. Paul street and St. Roch's the effect of the tide was severely felt by residents whose cellars have become wells.

Some idea of the height of the tide and the extent of the overflow may be formed when we state: that the cellars of Messrs. Lemesurier & Brouard, St. Joseph street, corner of Grant, are three feet deep in water.

The ice bridge was somewhat shaken by the combined influence of the tide and the high wind of the previous night and a large portion of it carried away, between the Island and Indian Point.

We understand that a considerable amount of damage has been done on the south shore.

FATHER POINT, 5th November, 1884.

A fearful snow and wind storm from the east has been raging since midnight yesterday all along the coast. The wind averages 70 miles per hour, the sea is tremendous and has crossed the highways and inundated the fields of all parishes along the coast here. The lighthouse and telegraph office is now completely surrounded by the raging waves and the boats are all unmoored.

The watch house, etc., here, and several buildings near here and at Rimouski have been carried away, besides fences, etc. Great numbers of people have vacated the buildings at Rimouski and much uneasiness is felt for the night's tide if the storm does not go down. The International Ry. track and roadway is washed away between Rimouski and Riv. No lives are lost so far as is known yet.

S. S. point. The signal and telegraph offices have now been abandoned, the station men having to take to the boats.

The greatest storm that has ever visited this vicinity for 40 years is now playing havoc with everything.

SAVOUSKEL, 30th November, 1884.

The high water so common in this harbor, has wrought terrible havoc in this town this afternoon.

Many houses, barns, stables and wharves are damaged and driven to the sea with the great waves. Damages over \$25,000.

The spring tides which are usual here, high at this season of the year, visited this place last night and today, combined with a raging snow storm and high north-east wind have swollen the river to an extraordinary height and the sea which is now running is the heaviest that has visited this city for years. The whole town of Rimouski is inundated and forms a part of the sea itself. A large number of houses, barns and stables are also various wharves and other buildings have been carried away with their contents. So far as heard, no lives have been lost. By 10 o'clock the roads are inundated and trains are retarded. People are carrying their houses of goods. The cattle have been turned loose and have taken to the water of the river. The sea is so high where goods were placed have become almost inaccessible. Much trouble is anticipated for the next high tide. The loss so far is estimated at \$200,000 to \$250,000.

SAVOUSKEL, 1st December, 1884.

There has been a snow storm raging here since last night and it still continues with heavy winds from the north-east. The sea is swelling over the wharf and has carried off a great number of houses of goods. It also has swept away the store where the telegraph office was. The children of the town are expected to stand another tide.

There was also a heavy washout on the I. C. R., some three miles out of Bic, this evening, extending 100 ft. long by 15 to 20 ft. deep. Trains are unable to transfer to-night.

QUEBEC, 7th November, 1884.

#### THE GREAT STORM.

The great storm of the last few days appears to have now entirely passed away from the Lower St. Lawrence, but not without leaving death and destruction in its path.

In the immediate vicinity of the city, the disasters arising from the storm have been chiefly confined to the damage and loss of property.

In the city, the principal sufferers are the merchants of the Lower Town whose stores face the river front. Both yesterday morning and the previous night, the high tides, increased by the violence of the easterly gales, raised the water of the river several feet higher than during the high tides of the last year. In fact, it is generally conceded that such high tides have not been seen here for half a century previously. Dalhousie street was so much flooded that the traffic was carried on by skiffs, and for a time passengers were taken on and off the ferry steamers in small boats, at a cost of ten cents each. Subsequently the ferry service had to be suspended for the space of a couple of hours, owing to the impossibility of landing passengers at all upon either side of the river.

In some places the water came up to Peter street. Champlain and Finlay market-places were both below water, and all the warehouses in the immediate vicinity were more or less flooded.

In the basement of the large new store of Messrs. Thibaudeau Bros. & Co., the water was three or four feet deep, and several bales of cotton and other goods were somewhat seriously damaged. The same thing occurred, though to a less extent, at the warehouse of Messrs. Hamel & Co.

In some of the grocery stores near the river the brooms and other articles were floating around in the water.

The largest sufferers were probably the flour and fish dealers, their stores for the most part, being nearer the river than any others. Messrs. Archer, Leduc & Co. and Nazaire Turcotte suffered in this manner, the largest sufferers in Dalhousie street being probably Mr. Carrier, who had a quantity of flour in bags damaged. Messrs. Renaud & Co. and other merchants having stores on St. Paul and St. Andrew streets, suffered in a similar manner. The river washed over all the wharves both on Dalhousie and St. Andrew streets. A quantity of cordwood was swept away, and some forty barrels of herrings had disappeared from Convey's wharf when the tide subsided.

At Lévis, a number of stores near the river were similarly flooded, and a quantity of property was swept from the wharves. A portion of the new Intercolonial Railway track was also submerged and some damage to it, is reported.

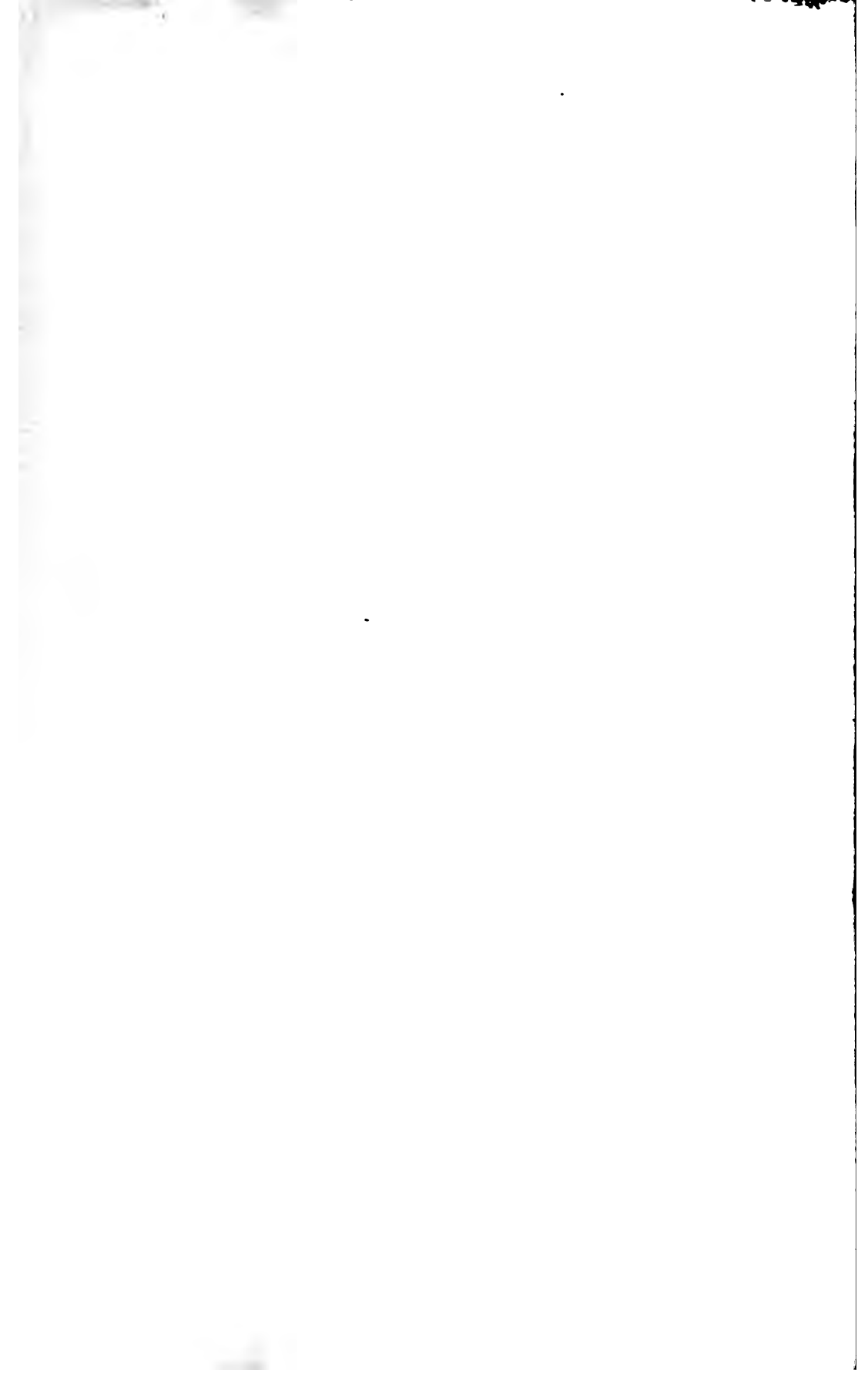
The St. Charles River overflowed its banks very considerably, flooding not only the village of Hedleyville, but also some of the low streets of St. Roch's.

CAP ROUGE, 6th November, 1884.

The steamer "Champion," with five schooners in tow bound for Quebec, put in here for shelter last night. One of her tow was cast adrift from her anchorage. The steamers "Etoile" and "St. Louis," both market steamers, with about 200 passengers on board, had also to seek shelter here, as a most violent hurricane was blowing. The tide rose about four feet above the usual spring tide mark, accompanied by a mild cyclone and snow storm, which lashed the waves into fury. Part of the village was inundated while the tide remained, but afterwards receded. Damage light. Two feet of snow this morning. Sleighing is excellent and the weather cold.

SOUTH QUEBEC, 6th November, 1884.

The high tides of last night surpassed those of last spring by two feet. It will be remembered that heavy losses were incurred last spring at this point, but they served as a warning, and the Grand Trunk built their sheds much further back. They, therefore, escaped a repetition of previous disasters.



## APPENDIX No. 17.

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REPORT ON WATER LEVELS, RIVER ST. LAWRENCE, BETWEEN QUEBEC, MONTREAL AND  
LACHINE BY R. STECKEL, CIVIL ENGINEER, 24TH NOVEMBER, 1891.

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### THE ACCOUNT

OF A GRADUAL BREAKING UP AND MOVING OFF OF AN UNUSUALLY  
THICK AND SOLID ICE BRIDGE, MAY 8 AND 9, 1836,  
IN QUEBEC HARBOUR WITHOUT CAUSING  
ANY DAMAGE.

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*(From the Quebec "Mercury" of 5th and 10th May, 1836.)*

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QUEBEC, Thursday, 5th May, 1836.

The ice bridge still stands firm in all its ample dimensions, having resisted the high tides and easterly gales of Monday and Tuesday yesterday it was crossed with heavy loads. The master carpenter of the Royal Engineers, had the curiosity to bore the ice in several spots, and ascertained its depth by means of a long pole with a crow foot projecting at a right angle from the lower end which, catching in the under surface of the ice, as it was drawn back, enabled him accurately to ascertain the thickness.

The result of the experiment showed, near the lower town market, 18 feet thickness: at a distance further from the shore, 17 feet, and still further out on the spot, where the hut was erected, the same depth.

Two feet of the lower surface, in all these soundings, was found to be soft, and offered but very little resistance to the gauging hook: proving, that notwithstanding the low temperature of the water, the under tow has been considerable, as also the action of current, in destroying the accumulated masses of ice which have this year formed the ice bridge. From the usual thickness of the ice and coldness of the water flowing from the upper portion of the river, this operation cannot proceed rapidly, and we fear that another week may elapse before the channel is open.

QUEBEC, Tuesday, 10th May, 1836.

The ice bridge has at length almost entirely disappeared, though large masses still adhere to the shore, and will probably not entirely be got rid of till the spring tides return.

Notwithstanding the ice had melted so much as completely to break the road, numerous foot passengers came across on Saturday, and some were seen traversing the broken and pathless plain as late as Sunday. By the frequent changes they were observed to make in their line of march, it was clear they met with difficulties if not with danger. No accident, however, is known to have occurred nor has the breaking up of the ice, so far as was its thickness, been attended by any mischief to quays, wharves, etc. The ice bridge at low tide once gave way with the high tide about noon on Sunday, but the ice on the batteries still remained. A steam boat from Montreal may probably arrive tomorrow, and is expected to call on Thursday. Boats from Three Rivers and above have this day arrived, and the ice has been a hindrance to the navigation being actually open. The ice on the river has been the subject of much talk and is still shore gave way on Sunday.

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APPENDIX No. 18.

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REPORT ON WATER LEVELS, RIVER ST. LAWRENCE, BETWEEN QUEBEC, MONTREAL AND  
LACHINE BY R. STECKEL, CIVIL ENGINEER, 24TH NOVEMBER, 1891.

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ACCOUNTS

OF THE

DISASTROUS BREAKING UP

AND MOVING AWAY OF THE

HEAVY ICE BRIDGE IN QUEBEC HARBOUR

29th MAY, 1874.

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*From the Quebec "Morning Chronicle" of the same date, and "Le Canadien" of 11th May, 1874.*

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## FROM THE "MORNING CHRONICLE," QUEBEC, 9TH MAY, 1874.

## BREAKING UP OF ICE BRIDGE.

At twenty-five minutes past three o'clock yesterday the ice bridge concluded to leave and moved off accordingly in a very majestic manner with the tide. The steamers "Rescue" and "Prince Edward," both belonging to the St. Lawrence Tow Boat Company, had been working since Wednesday in trying to clear a channel across the river, and but a small strip of ice, not wider than the length of the "Rescue," remained to be cut through, when further efforts to separate the floating mass became unnecessary as it commenced to move off. The "Prince Edward" at once made the best of her way to the wharf at Lévis, where she took shelter below it; the "Rescue" also managed to get clear of the field of drifting ice, by putting on steam and making directly for Indian Cove.

As soon as it became known that the ice was on the move, the crowds that had been watching the steamers all day from Durham Terrace and from the wharves, received a vast accession to their number. The good folks in the Lower Town, where business has been at a stand-still on account of the unusual delay in the opening of navigation, became wild with excitement and everywhere people might have been seen talking the matter over excitedly, or taking gigantic strides riverward to feast their eyes on the long wished for sight.

Picking up our hats and becoming suddenly oblivious to the importunities of our devil for copy or complimentary tickets to see the Black Crook or something, we rush frantically down to the river and presently find ourselves on the wharf in the very midst of an enthusiastic multitude.

And surely enough, there the whole field of ice extending from shore to shore, and reaching away up and down the river as far as the eye could see, is moving off steadily and with irresistible power. The peculiar noise caused by the grinding action of the different pieces upon each other becomes louder and louder as the jam becomes greater; but nothing stops the drifting mass and very soon the blue open water appears in the direction of New Liverpool, and an hour afterwards, the last of the ice halts with the turning tide before the Citadel. But the satisfaction felt at the raising of the ice blockade and the opening of navigation, is damped by the record of the wholesale disasters to shipping which has taken place. Such a destruction of property caused by the moving ice in the vicinity of the harbour is, we believe, quite unparalleled.

The scene of the havoc is at Blais Booms, and a visit to the place at once convinced us that the most disheartening rumours that had reached us were not exaggerated. Ocean steamers, propellers, river craft, tugs, side-wheel steamboats, and all, manner of vessels are either damaged, sunk, capsized, or broken up.

The fine iron sea-going steamer, the Napoleon III, is a complete wreck; one of her sides is jammed against the corner of the pier at which she was moored and stove in, and the others have been completely smashed by the ice. Her deck is lifted up, and the coal bunkers, which are full, are moved upwards through it; the bulwark and railing on the port side, the side smashed by the ice, has fallen outwards, and the engine house is a complete wreck. She is the property of the Dominion Government.

Below the wreck of the Napoleon III., lies a sunken propeller over which the ice has built up to a great height, her upper works and broken funnel being alone visible at high tide.

The *Druid*, another Government steamer, also of iron, is considerably injured, and lies over on her side. The steamboat Castor, is sunk and a complete wreck. The steamer Georgia, belonging to the Gulf Ports Company, is also sunk, having had her side crushed in by the ice. The steamboat Rescue, belonging to Mr. Dinning, has, like the two last, gone to the bottom, and is partly broken up. The steamboat Hector is much injured and was not expected to float through the night. The St. Lawrence Tow-Boat Company's tug, the Napoleon, is also broken up. Several vessels, including the Mersey, Shannon, the Norwegian ship Harold Haarfager, and others laying at Dinning's, were

either carried away or more or less damaged. The steamer *Miramichi*, has suffered considerably.

Among the steamboats which have been more or less damaged are the *Canada*, *Secret*, *Providence*, *Conqueror*, and *Bellechase*, and several schooners, one of which, the *Hermine* had taken in a cargo. There are many other craft lying further up which have also suffered, and some other damage, such as carrying away booms, etc., has been done. It is impossible to make any approximative estimate of the value of the property destroyed, but it will considerably exceed a million of dollars.

The Gulf Ports Company are insured, but the loss will fall heavily on the owners of the steamboats, and other river craft.

In 1836, the ice bridge moved off on the 8th May as it did this year. The *Rescue* returned last night and will commence running to-day on the ferry to the Grand Trunk station at Lévis. Capt. Moore deserves great credit for the manner in which he handled her during the time she was engaged in breaking up the ice bridge. The *Prince Edward* will also commence her regular trips as ferry boat to-day.

## "LE CANADIEN," QUEBEC, MONDAY, 11TH MAY, 1874.

### THE ICE SHOVING AND ITS GREAT DISASTERS.

The ice bridge which generally leaves the river in a very quiet way, has moved away this year, in causing disaster valued at many thousand dollars. These damages, it is said, are due to the unusual thickness and soundness of the ice.

Friday, 8th May, day of the shoving, the steamers "*Prince Edward*" and "*Rescue*," were working, as previously, to break through the ice, at about the middle of the river, so to cause a channel to be formed from shore to shore, when at 3.20 p.m., the bridge losing its hold at the "*Key*" commenced to move down.

The "*Prince Edward*" had reached her wharf some time before, but the "*Rescue*" was taken amidst the floating mass, and carried down by it. She succeeded to get out of her serious position somewhere at a little distance from the Island of Orleans and steamed to Indian Cove. Mr. Wagner and his men, are said, to have also contributed to accelerate the departure of the ice by their sawing through at many places.

But the ice bridge, offended, if we may say so, at being torn to pieces by the steamers and sawers, and driven away when it was not yet ready to leave us, took vengeance during its shoving, and indeed it was only with too much success.

In Blais' Booms, at Cap Blanc, had wintered a hundred vessels of all kinds and sizes; steamers, barques, schooners, boats, &c. All were near one another. The ice took a direction towards these booms with a dreadful strength and rapidity, jamming all these vessels one upon one another, some of which were crushed, upset and sunk.

The beautiful iron steamer, the "*Napoleon III*," belonging to the Government, which was in the first row, was pushed against the angle of a pier to which it was moored, crushed and nearly cut in two. She is full of water. Her engine was broken. The "*Druid*," another government iron steamer was slightly damaged.

The "*Georgia*" of the Gulf Steamers Company had one of her sides broken through and sank. She is split open from stern to stern, and has holes of some twelve feet in her hull.

The "*Castor*" crushed and sunk.

The "*Rescue*," "*Canada*," "*Beaver*" of the Royal, have also been crushed and sank.

The "*Rival*" is greatly damaged as well as the "*Shannon*," and the "*Conqueror*," the "*Miramichi*," "*Secret*," "*Providence*," "*Bellechasse*," and the "*Hector*" were also more or less damaged.

The Norwegian ship "*Harold Haarfager*" and others which were moored at Dinning's wharf have been carried away, and more or less damaged.

Many schooners have also suffered : two of these had already been loaded with provisions for Gaspé, they were torn to pieces and they sank. They were owned by Captains Berthelot and Kennedy.

Piers and portions of wharf have been torn away. Nothing resisted to the ice where it struck. At many places ice is piled in large-sized cakes and covers partly the vessels which it broke. The Gulf Steamers Company has insurances : but the loss is very considerable for other owners of steamers, schooners, &c., who had none or very little insurance. Some people estimate the damages at more than half a-million dollars.

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**APPENDIX No. 19.**

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**REPORT ON WATER LEVELS RIVER ST. LAWRENCE BETWEEN QUEBEC, MONTREAL AND  
LACHINE, BY R. STECKEL, CIVIL ENGINEER, 24TH NOVEMBER, 1891.**

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**EXTRACTS**

**FROM**

**“LA MINERVE” (MONTREAL)**

**“LE CANADIEN” (QUEBEC)**

**AND THE**

**“QUEBEC MORNING CHRONICLE”**

**RELATIVE**

**TO THE**

**DISASTROUS SPRING FLOODS**

**OF**

**1861, 1865, 1873,**

**BETWEEN QUEBEC AND MONTREAL,**

**Showing the great destruction of property and loss of life caused by them, etc.**

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"LA MINERVE," MONTREAL, 16TH APRIL, 1891.

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## FLOOD IN MONTREAL.

*Fire.*

A quarter of the city is flooded since 7 o'clock, Sunday.

The ice from the lakes is accumulated between Victoria Bridge and Ste. Helene Island, and the waters, prevented from passing through their ordinary channel have overflowed. The whole of Griffintown and part of St. Joseph and St. Antoine suburbs are inundated. Distress is at its highest pitch. The authorities, the mayor, Mr. Courso, superintendent of police, &c., are up since very early yesterday morning: help is distributed to the greatest sufferers. All boats have been put in requisition. The whole of Commissioners street is covered with a depth of water varying from 2 to 3½ feet. The cellars of stores facing the harbour are flooded and the doors of many of the stores have been broken by the ice. The Montreal College, it is said, has been shut. The Grey Nuns have been forced to leave the lower floor of their convent on account of the water. The gas works have suffered so much that it will be impossible to have them working before many days.

The village of Laprairie and the low part of Longueuil village are also under water.

And as if all the elements had decided our ruin, a sudden fire broke out during the flood and the dreadful voice of the tocsin was heard. It was destroying the offices and the vaults of the inspection office for by its cause being unknown.

We notify the public that the boatmen are under the immediate direction of the police, and that their services must be given gratuitously to the sufferers by the flood. The City Council held an extra meeting yesterday morning, and a Relief Committee has been appointed, which at once began to meet the most pressing wants. Losses are estimated now at more than one million dollars, affecting grain as well as other goods of all kinds.

At the moment of going to press, the level of the water tends to a decrease.

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"LA MINERVE," MONTREAL, 17TH APRIL, 1891.

## THE FLOOD.

The water has decreased to the top of the wharves.

Some streets of Griffintown are yet under water, but if the water goes on decreasing, during night the flood will be over and nothing but its disasters will be seen. We cannot say at this moment the amount of the loss suffered by people in Griffintown, St. Joseph and College streets, &c., and by merchants on St. Paul and Commissioners streets.

We learn that the disasters caused by this flood have been considerable in Laprairie, Longueuil and Beauport. A large number of cattle were drowned and many houses have been badly damaged by the ice in the villages of Laprairie and Longueuil. We have to report many serious accidents. A young child has disappeared from his parents' home since Monday, and has not yet been found; a boat containing five persons upset, and three of them, Cismachen, his daughter and one Ryan, were drowned. The corpses have not yet been found.

The greatest sufferers will probably be the numerous flour and grain merchants of Commissioners street and those in the neighbourhood of St. Ann's Market.

To complete our misfortune, a heavy snow had, helped by a north-east wind, came over the city in the early part of the night of Tuesday. An idea of the sufferings in Griffintown can be formed when it will be known that the people are living in attics without any fire, exposed to the cold and to all inconveniences of weather. A friend who has visited the place tells us that the distress is great. On the spots freed from water the walls of houses are the same as well as their floors. Firewood piled in

many places has been carried away by the stream, and difficulties are yet experienced to reach certain portions where the flood still makes terrible ravages.

In some places the streets are impassable, and in some others circulation on foot is made through a depth of two to three feet of water.

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“LE CANADIEN,” QUEBEC, 12TH APRIL, 1865.

OPENING OF NAVIGATION.

The lower part of the ice covering Lake St. Peter began to shove yesterday afternoon and caused a rise of more than six feet in the level of the river at Three Rivers. Half of that city is under water ; damages are heavy. Turcotte's Wharf has been carried away, and Farmer's Hotel, as well as other houses, have been seriously damaged.

At Cap-Rouge, the ice is yet many feet thick.

Opposite Quebec, the ice bridge is still firm, and teams, as well as people on foot are seen crossing over it continuously.

Above Montreal, and on Lake Champlain, navigation is opened and steamers have begun their regular trips.

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“LE CANADIEN,” QUEBEC, MONDAY, 17TH APRIL, 1865.

GREAT FLOOD—MORE THAN FIFTY LIVES LOST—CATTLE LOST—HOUSES, BARNs, &c., DESTROYED, &c., &c.

The following details are from “l'Echo du Richelieu ” and the “Gazette de Sorel.”

SOREL, Thursday, noon, 13th April.

Since a few days the water has reached a height which caused fear for the properties situated on the Chenal du Moine and the adjoining islands. Everywhere the fields were submerged and the farmers could get an entrance to their houses only by the use of canoes ; the greater number of families had lodged in the garrets of their houses, patiently awaiting there the end of their misfortune ; cattle were moved to the lofts of barns, a great part of which had already been destroyed by the flood which was threatening every day and with the first strong wind, to ruin them all. This day, alas ! was not long in coming. Yesterday noon a strong wind from the south began to blow with such violence that many persons in the city feared for their buildings. Some sailing boats anchored at the mouth of the Richelieu River began to drift rapidly down the St. Lawrence under the action of the wind, which seemed to spare nothing. These vessels, however, resisted ; one of them only, lost her masts, and the tremendous waves would have filled her had it not been for two young men left in charge of her, who succeeded to hold her upon her anchor till relief was given them, which was very opportune. Besides a few other small accidents, more or less serious, such as loss of wood, of sheds, &c., we have no mishap to deplore in our city.

But what was more to fear, were the probable sufferings the people of Ile de Grâce, Ile aux Ours and of the “Chenal du Moine ” were exposed to endure during this frightful storm.

In fact, towards 10 o'clock last night news reached the city, by the crew of the propeller “Bell,” under Captain Chas. Armstrong, whose devotedness was very great, during the storm ever increasing in impetuosity, that houses and barns on the islands and along the Chenal du Moine were being carried away. Immediately, Mr. Sincennes ordered two vessels of the Richelieu Company to be rigged and to leave for the relief of the inhabitants, some of whom, it was said, had been drowned and some others had lost all their properties. At about midnight, the steamer “Terrebonne ” under the command of the experienced Captain Roy, proceeded at full steam to the island. It reached Ile de Grâce, where the “Cygne ” had reached during the day, and which had on board a great number of persons having escaped the danger of the storm.

At 2 o'clock this morning, "l'Etoile" under the active Captain Malhiot was steaming towards Chenal du Moine in order to help, if it was yet possible, the unfortunate flooded *habitants* of that district. The "Terrebonne" came back here this morning at 10 o'clock, with a distress flag flying at her stern mast and having on board some forty survivors from Ile de Grâce and Ile aux Ours.

The news brought was of the most alarming nature; all the houses, or nearly so, had been carried away; twenty or twenty-five persons, partly women and children, had found a watery grave. The barns, containing cattle, the houses, &c., of the farmers, were no more to be seen. A few minutes later "l'Etoile" reached here with 150 people or more on board, from the Chenal du Moine. Nothing was more heartrending! their misery was the greatest; scarcely were they clothed! The great number were bare-headed and barefooted.

The city is in the highest state of excitement! the clergy, the city council, His Honour Judge Loranger, Mr. Sincennes, and the leading citizens of Sorel are busily engaged giving a shelter to these poor people. At this moment, the great number are lodged at the City Hall; many are receiving the hospitality of particulars.

The approaches to the wharf of the Richelieu Company are incumbered since the morning.

The number of the victims of the flood, now here, is about 250 to 300. One child only has been brought here in a state of death; no other dead body has yet been recovered.

Very nice courageous acts are related of persons, who during the circumstances, have employed all their means for the rescue of these unfortunates.

#### LATEST NEWS.

2 p.m.

A meeting of the citizens called by His Honour the Mayor, R. H. Kittson, Esq., was held this forenoon at the Court House; every one present has shown a great liberality; in the space of a few minutes the subscriptions for the relief of the flooded people reached \$1,600. This amount shows the zeal of our leading citizens, and one will not be astonished when it'll be known that the Messrs. McCarthy have personally given \$250: Mr. Sincennes, \$150; Hon. Judge Loranger, \$100; Richelieu Company, \$50; Hon. David Armstrong, Mr. M. C. L. Armstrong, \$60; Dr. L. U. Turcotte, \$100; James Morgan, \$50; W. Lunan, \$50; A. N. Gouin, \$50; P. R. Chevalier, \$50; W. Buttery, \$50; Eugène Bruneau, \$40; and many others who handsomely did credit to our population. Subscriptions are yet given actively and liberally.

In the Chenal du Moine, no lives were lost; the number of buildings, houses and barns, carried away is from 60 to 70; out of which 24 are houses. One farmer named Millet, lost 13 buildings. It is impossible to tell exactly the number of cattle lost, but it is very large. On Isle de Grâce, 19 or 20 people perished. One Pelouquin, lost 4 children, and he himself owes his life to his rescuers. One Ethier, of Ile de Grâce, saw his wife, his sister-in-law and two of his children drown under his eyes. Another, Joseph Lavallée, of Ile de Grace, had taken hold of a branch of a tree, with his wife and 4 or 6 of his children, where he stood during 16 hours at the mercy of the waves: he saw one of his children perish, his wife die at his side, and yet he was strong enough to wait with the balance of his family till he was relieved.

The city is yet in a state of excitement. The water recedes visibly. Let us hope that the adjoining parishes that have not so severely suffered by this terrible calamity will join the population of Sorel to provide, as much as possible, to the wants of these unfortunate compatriots.

*Berthier.*—The news coming from the "Petit Nord" is alarming; everywhere the buildings have nearly completely disappeared. 17 lives, it is said, have been lost, at Ile du Pads.

6.30 p.m.

The "Terrebonne" is coming back from a second trip to the Islands; her distress flag is yet flying. She brings back two corpses: the body of the wife of Joseph Lavallée (above mentioned) and the one of a young child; also a great number of cattle.

Oh ! May God give us courage and protect us during these misfortunes.

During the storm the "Cygne" could scarcely hold herself on her anchor. Captain Labelle and 2 men resolutely took a canoe and were rowing towards the direction whence shouts came to from people in danger of drowning. But their frail craft was resisting with difficulty the storm, the waves were filling it ; they reached some trees where they had a shelter. There, they found a young girl, who by one hand, was holding the branch of a tree, and maintaining herself above the water by means of a wash-tub which she had used for reaching the tree. At the sight of the canoe nearing her, she threw herself in, but this additional weight was nearly upsetting the canoe which was nearly three quarters filled with water, when the young girl took a resolute hold of the wash-tub and during the time the men were keeping the canoe next to the trees, she succeeded in emptying it. At a little distance further, another young girl, with 2 young children in her arms, was standing in a tree cracking under the repeated lashes of a violent wind.

After 3 hours terrible pangs, these men succeeded in rejoining the "Cygne." Besides Capt. Laforce, who then risked his steamer, to save the wrecked people, and Capt. Labelle, whose heroism we mentioned above, it is stated that Mr. J. B. Lavallée, of Sorel, who was on board the steamer, exhibited during all that time a courage proof against everything and a great presence of mind ; without the co-operation and the experience of this courageous man, it is probable, that we would have to deplore the loss of the "Cygne," and consequently that of many lives.

The passengers of other steamers, during the same night and during the day, yesterday, picked up numerous wrecked people, men, women and children, whom they brought to Sorel, half dead by anguish and misery.

One Lavallée *alias* Blache, had seen his house crushed by the waves and he had taken to a canoe, with his wife and five children. A few minutes later, the canoe was crushed against the trees. The poor mother took hold of the branches of a tree, and her husband succeeded in reaching another tree, with his five children. He stood there, one child under each arm, and the other three near by, during sixteen hours. His wife, exhausted by hardship, was drowned in his presence and one of his children died in his arms. When they were relieved, the children were benumbed by cold ; but as soon as their father was in the canoe he paddled courageously towards the steamer. The corpse of his wife was recovered yesterday.

Will you have something more thrilling ? Read ! A woman was in bed on the verge of confinement. The husband seeing that the storm was threatening his house, asked his wife to have the courage of getting up so as to reach the canoe. She answered him : "Save yourself with the children, if you can : as for me, I see it is impossible ; but we will meet again in the other world." And while she was speaking the house fell down and all were thrown in the water ! This is no romance. It is naked truth. These events have happened the day before yesterday. But we have said enough.

We read in the second edition of the "Union Nationale" of Saturday :

"We have obtained some more details on the flood which further increase the frightful picture of its disasters, which we have extracted from the 'Gazette de Sorel.'"

The Rev. M. Plinguet, arriving from Ile du Pads, this morning, brought the sad news that 17 persons have perished on that Island, whereas 25 perished on Ile de Grâce and Ile aux Ours. It may be that a greater number have lost their lives ; we are not sure yet of having ascertained the whole extent of hecatombs.

All the houses, barns, &c., from the division road of St. Cuthbert down to the Common of Maskinongé, on a length and a breadth of about 5 leagues, have been blown down, carried away and destroyed.

A letter from Ile du Pads, of 13th April, 1865, contains the following :

"The water was 6 inches higher than the day before. We cannot form an idea of the spectacle presented by this flood ; water has never been so high since 67 years. Towards 2 p.m. yesterday blew a furious wind, which lasted till night, keeping steadily at its height for some 3 or 4 hours. The wind was so strong that in my stone house, which is very solid, we continuously felt the floor shaking under our feet. The waves

outside of the river banks were tremendous ; they struck with such a force against every obstruction that they were flying over the buildings ; above the surface of this vast stretch of water the atmosphere had the appearance of being filled with drifting snow (poudrerie) as in winter.

" I learn at this moment, 8 a.m., that three houses, at Ile du Pads, were blown down by the wind and carried away with all their contents ; also 17 lives were lost."

Mr. Belcourt hands us the following letter from Three Rivers, dated 14th April.

" I assure you that the 12th April, 1865, will be engraved forever in the memory of the Trifluvians and of the inhabitants of the adjoining parishes. In fact, I have never seen such a frightful spectacle as that witnessed in the afternoon.

" The water was extraordinarily high and the ice from the lake was moving down, when commenced a gale from the south-west which broke down fences, vessels, houses, barns, &c. with a terrible rapidity. The losses are immense here : not less than 15 houses have been destroyed, wholly or partially, without taking into account the sheds, stables, &c. And the worst of it is, that the poorer class is partly affected. The water has caused damages specially on St. Philip and St. George streets, and the ice on Notre Dame street, near the little bridge. The house of Seymour, belonging once to Gilmour, has been crushed with all the furniture, and three other houses this side of it have had their fronts torn so much that furniture was drifting out. The river was covered with poles, posts, boards, bedsteads, commodes, carts, bark canoes, and even whole buildings. And the most terrible is that we have to register two lives lost : In the outskirts of the city, F. Dufresne, and one of his sons, were drowned in a small scow. The eldest of his sons escaped. I think some lives were also lost in the country. It is related that one Syrenne was drowned at Bécancour, and according to rumour, a whole house with the family in, in the same parish, has been carried away. At Yamachiche, at " la Pointe au Sable," and on the south of the river, opposite Three Rivers, a great number of buildings have been carried away, some with the cattle in. I am just informed that at Yamachiche, no less than fifty buildings of all kinds have been demolished : it is stated that a lady lost her house, barn, and even her cattle. I believe that when all the damages caused by these three elements which have struck upon our district will be all known, the losses will be incalculable.

" Yesterday, I went all around town, and I assure you that it is very painful to see everything disturbed : everywhere we meet but poles, boards, furniture, and doorsteps hanging around : a whole house floated off and grounded into the street where Proulx lives : another house was carried through the street where Thivierge lives and grounded on the Hay Market square.

" The body of F. Dufresne has not yet been found : that of his son has been recovered : as the water is receding quickly, hopes of finding the father's body are entertained.

" A small steamboat left here for Sorel, yesterday : the lake seems to be clear of ice."

*Minor News.* Friday, 14th April, in the afternoon, a portion of the ice bridge opposite the town broke and moved down with the tide : but a large floe of ice, from above, opposite the Grand Trunk Station, a few moments later, came down on this side and grounded in front of Finlay Market and took the place of the drifting ice in such a way that a new bridge was formed opposite the city, over which people on foot were seen crossing to Levis as late as noon, when it disappeared with the ebb : but what is most singular, during the afternoon of the following day, another floe of large dimensions closed the river at the same place, forming a third bridge over which circulation between the two shores was renewed, though with danger. Towards 5 p.m., at the time when the boatmen were yet afraid to cross over this improvised bridge without their boats, an intrepid Irish woman, not to say imprudent, left the Grand Trunk Station, and daringly proceeded to come alone over to this shore, amidst imminent danger and frequent open spaces here and there, and when the floating pieces of ice could separate and move off downward. Happily, Ellen Wall (such was her name) did so well that she got without hindrance to Finlay Market, where a large

crowd having assembled to look at the end of this act of temerity, applauded the child of the Green Erin. A man, wishing probably to follow Ellen Wall's example, left from this side towards Levis, but the ice shoved before he could reach his destination, and he was carried down to a considerable distance ; he was rescued by men in a canoe.

19th April. A painful rumour, says "l'Union Nationale" of yesterday, was circulating the day before yesterday, that not less than 80 persons had been drowned during the flood in the Grand Nord, Parish of St. Cuthbert. We have yet no positive data, but such a large number of houses have been removed, that we fear the chapter of misfortunes will be increased by new hecatombs.

In St. Therese Island, opposite Varennes, two houses were crushed by ice ; one, in stone, was the property of the Estate of the late Mde. Joseph Laporte, and the other belonged to L. A. Robitaille, Esq. ; the tenants have nearly lost all their furniture and grain.

The wind caused yet more extended damages all along the river. The water has eaten away the shores in a dreadful manner and part of the wharves are demolished.

A letter from *Varennes* says : "We see but demolished barns. Five of these are totally wrecked. The good sisters of "l'Hospice de Lajemmerais" have experienced a terrible mishap. Every one knows that the pecuniary means of these holy nuns to do good are very limited. Some years ago they had a chapel built up with brick, in the rear of the principal body of the hospital, in order to strengthen this building and to facilitate pious exercises. The gale swept the whole chapel away. The roofs were found two arpents further."

Mr. Hyacinthe Desrochers, of 'Ile Ste. Therese,' was very near being killed ; the roof of his barn fell upon him and he was pulled from under the ruins half dead. One of his shoulders is broken and his neck nearly so. He suffers greatly from pains in the stomach. Dr. Painchaud has been called to attend him.

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## "LA MINERVE," MONTREAL, 11TH APRIL, 1865.

### THE RIVER.

Sunday morning, the few arpents of *bordage* ice, opposite the town, have been removed by the stream and the water begins to recede from over the wharves, but they are yet covered by large piles of ice.

The "Iron Duke" and the "Fashion" steamed Sunday as far as the foot of St. Mary's Current and are yet anchored at this place.

It will be hard for the ferry to begin its operations before the end of the week, on account of the obstructions by the ice. On the Longueuil side the ice piles extend from the bottom of the river to many feet above the surface of the water.

Five or six schooners whose winter quarters were in the Boucherville Islands have arrived at the Canal.

The news received from the district below is all of the same nature. The place, most affected, is, we believe, the Island opposite the Village of Boucherville. On Tuesday last, the ice carried away two barns and one house belonging to Mde Vve. Quintal, of Boucherville, and also another barn. One man, named Lesperance, was in this house with some fifteen children when the ice was nearing the place. He quickly passed the children through a window and deposited them in a boat ; at the instant, he was placing the last child in the boat, a cake of ice carried away the shutters and one minute later the house was removed. This island is not at a great distance from the shore of Boucherville, and as all the doings of the inhabitants could be seen from this shore, a large crowd gathered to witness the scene.

It is said that the ice shoves opposite St. Sulpice have formed a wall reaching the height of the telegraph posts.

The river is cleared as far down as Lanoraie, but the ice between Lavaltrie wharf and the Island opposite, is yet solid, so that steamboats will not be able to call there for some time.

Sunday, canoes were yet used for circulating in the streets of Berthier: this unfortunate village is now flooded since a fortnight. According to the latest news, the water which was now reaching the Church of *Le du Pads* threatens to invade the whole of this Island.

In the *Cinema du Moine*, the water covers the land as far as the eye can reach. The ice upset one house and one barn, and we have not ascertained if any other loss has taken place. The poor inhabitants are forced to leave their premises or to use scaffolding for remaining in.

Canoes are fastened at people's doors and everyone rushes at them when the ice becomes threatening.

The flood was seriously felt at Sorel and the houses on the bank of the river have been inundated.

The "*Journal de Quebec*" of Saturday says:

Notwithstanding all what is said, the ice bridge opposite Quebec, is yet solid. Yesterday, a chain weighing more than 2,500 lbs. has been taken over the river in a weight drawn by three horses, one in front of the other, from the Grand Trunk Landing, without any accident happening.

### "LA MINERVE." MONTREAL, 12TH APRIL, 1865.

#### FLOOD AT THREE RIVERS.

9th April, 11 a.m. The outskirts of the city are flooded and a great part of our unfortunate town presents a painful appearance. The poor sufferers are without fire, nor bed, nor bread. The whole of St. Philips ward is flooded and the water, on Notre Dame Street, reaches the store of Mr. Houlston. The boatmen give us a remembrance of Venice during Carnival. The water is stated to stand higher than during the great flood of 1843.

The ice of the lake is yet solid: but if it comes down during this high state of the river, we fear immense disasters.

11th April, 3 p.m. At two o'clock sheets of ice began to pass down: they are thought to be coming from the lake: water rose 6 inches since last night.

A shed, on Turcotte's wharf, has been torn into pieces and carried by ice.

It is thought the ice will cause terrible damage: half of the town is under water and we cannot ascertain the extent of the distress existing everywhere.

#### THE NAVIGATION.

Navigation is long to open. The day before yesterday the steamboat "*John Brown*" came in the harbour, and yesterday, the "*Richelieu*" arrived.

The steamboat "*Richelieu*" came from Lachine, through the rapids, yesterday afternoon and entered into the Canal Basin.

This nice boat has been bought during the winter by the Trinity Board of Montreal, and given to the charge of Capt. Cotté, superintendent of pilots: she will be used for the buoys services and the general direction of the lighthouses between Quebec and Montreal.

Yesterday water rose many inches and covers again the wharves. This slight rising caused the ice grounded on these wharves, to flow away.

At the foot of the current, canoe men have organized a regular line of crossing.

Our telegraph correspondent from Three Rivers, gives us, to-day, some news and we call the attention of our readers to our special despatches.

The *Richelieu* Company has been good enough to hand us the following letter from Three Rivers, received yesterday morning.

THREE RIVERS, 10th April, 1865.

Since my last letter, water has not receded; on the contrary its rise has been alarming. The ice breakers on Molson's Wharf are covered by 2 or 3 feet of water.

The Farmers' Hotel is all surrounded by water. If the lake ice moves down, we fear every house on the edge of the river will be crushed and even carried away. In

short, all the low part of the city is under water, this means about half of the city and it forms the places of residence of the poorer class ; so that you may judge of the existing misery. We are happy to see the corporation and charitable people, doing their utmost, to help the unfortunates. It is thought, that in many places, water rose by 8 feet, at least, and at this hour, it is yet rising. It is related that the ice is yet very solid below.

I regret that I am not able to keep you posted by telegraph, on the disasters the ice will cause here, because the wire has been carried away at la Point du Lac.

When I was finishing this letter, I received a despatch from the agent of the Richelieu Company, at Batiscan, Mr. Marchildon ; he says the ice has moved down as far as Grondines and that Batiscan is extraordinarily flooded and that everywhere they are surrounded by water.

At Quebec, the bridge is of a distressing firmness.

The "Canadien" of the 10th says :

"Saturday, two horses drawing three very large pieces of square timber crossed the bridge and reached Lévis without accident. Last night, about 6 o'clock, a boat from Island of Orleans, carrying five men, has been seen reaching the lower edge of the bridge.

"This boat which was of large dimensions, was drawn on the ice and taken without any mishap, by the men, to the Finlay Market.

This morning, summer as well as winter vehicles cross over the bridge with as much safety as ever.

## "LA MINERVE," MONTREAL, 13TH APRIL, 1865.

### THE SEASON.

Yesterday was characterized by a furious gale which deprived the spring of its gentle features.

The wind blew the hats off the heads of people ; roofs of houses were thrown down ; in Griffintown, it helped in drying the floors on account of houses being ventilated by the roofs.

The large warehouse, on Pointe à Callières, Commissioners street, belonging to Mr. Logan and occupied by M. T. Marc Bryson, had 15 to 20 ft. of its roofing removed ; one large stone chimney was blown down ; two soldiers, members of the band of the 60th, that were passing at the foot of said building were very much frightened.

Another gentleman, student-at-law, was very near being struck by a sash detached from the second floor of a house on Beaver Hall. The wind did some good to the harbour ; it removed nearly all the ice piles. And we have only to regret that the wharves are yet under water and no steamboat can be snubbed.

We learn that the two steamboats that were anchored yesterday opposite Hochelaga, dragged their anchors. Damages are feared.

We hope the end of our narration of disaster along the river is at hand. The only fact that we have to register concerns Ile Bouchard : A barn in the loft of which cattle had taken refuge having collapsed, two horses and four cows were killed. A little further down the river the waters carried away a portion of some islands, and swept away barns, ice-breakers, shrubs and large trees.

We do not expect a steamboat from Sorel before 2 to 3 days.

The Richelieu company has been good enough to communicate to us the following details concerning Three Rivers and its neighbourhood.

### THREE RIVERS, 11th April, 1865.

Since yesterday, water continued to rise till about 10 o'clock in the morning, when it began to fall a little. Ice floats about in small quantities since this morning. This is generally believed to be the beginning of the shove of the ice from the lake. The inhabitants say that the water has never been so high since 60 years. To give you an idea of its height I have only to tell you that it would be possible to take a canoe on Notre



strength of their bodies. Each cracking of their houses resounded terribly in their souls, for the last efforts of their retreat, were like the voice of a solemn warning.

These moments of supreme anxiety were not, however, of long duration ; fears were to be succeeded by the most terrible of all realities. Roofs were scattered on the waves ; barns soon were demolished, and the cattle kept on scaffolds raised in the lofts were precipitated in the water and drowned.

It is difficult to hold back the irresistible emotion which takes possession of our heart at the idea of the most awful catastrophe that ever visited this country. Thousands of compatriots, some friends, some relations perhaps, have passed without transition from wealth to the most abject poverty. Alas ! they have not only lost their goods, but their families, or they have died themselves. Yes, they sank under an errand wave. The land they had fecundated by their sweats is to-day the bed of an abyss, the saddest of all graves. How can we describe the painful scene of the gale breaking the foundations of houses and precipitating the inmates into furious waves. Here is a father forgetting himself for saving his wife, and who disappears under the water when he believes to have hold of her, the anchor of his family ; there is a mother breathing her last breath and calling the names of her children ; here is a child, weak, being without any support, who is crushed by wrecks before being in possession of his watery grave.

Such was, however, the spectacle to be seen Wednesday last, amongst the Islands of Sorel. In some hours 50 victims were violently withdrawn from this world ; 2000 persons could, from one second to another, have the same fate.

\* \* \* \* \*

Here follows an account of the lives lost and damages done to properties, according to "la Gazette de Sorel." It is believed 50 lives in all were lost.

#### ILE DE GRACE.

Joseph Lavallée's wife and one child ; Louis Cardin's wife and three children ; Pierre Ethier's wife, three children and his sister-in-law ; four children of Pierre Peloquin ; two children of Ignace Lavallée ; his wife has been rescued in a dying state. One child of Paul Cardin.

With the exception of three, all the houses of the Island have been thrown down by the wind and the waves, and most of the cattle perished ; also nearly the whole of the grain, etc., destroyed.

#### ILE AUX OURS.

Ignace Bergeron, Pierre St-Martin, Frs. St Martin, Pierre Bergeron and Pierre Plante have lost their houses, barns, grain, cattle, &c. It is supposed that Pierre Plante is drowned because he has not been seen since.

#### ILE MADAME.

Bruneau Ethier, Bélonie Cournoyer, Joseph Cardin and Athanase Cardin lost their houses, barns, cattle and grain. Bruneau Ethier has 1,000 bushels of oats in his barns. The other inhabitants of these islands have more or less suffered ; no details are yet at hand.

#### CHENAL DU MOINE.

Seventy-one houses, barns, &c., have been swept by the gale. A large number of cattle have perished and a great quantity of grain and furniture has been destroyed, but no life lost. The inhabitants deserted their homes at the beginning of the storm and succeeded in reaching the woods in canoes.

#### ILE DU PAS.

Seventeen buildings, houses and barns, are said to have been carried away, but we do not know if this is the correct figure. Two scows filled with people have been driven as far as the lake. No victuals were on board. But we have no reason of dreading that they have been wrecked.

## THE STORM OF WEDNESDAY.

The storm of Wednesday is changed into a veritable disaster, not only in Montreal but everywhere over the country. In Montreal, the principal accidents are the following. Broken trees were first noticed; one of them is lying on St. Francois Xavier Street, opposite the store of Benning and Barsalou.

A great number of trees shared the same fate on Sherbrooke Street, St. Lawrence Street and Viger Square; the quantity of trees broken on the mountain is incalculable.

Fences and hedges of all kinds have been thrown down in thousands of places. In many instances cattle took to their heels. On Wellington Street especially, opposite Mulligan's Hotel, a fence is destroyed.

More than one street lamp was put into pieces, one amongst them, at the corner of Notre Dame and St. Sulpice Streets. Some fifteen to twenty houses had part of their tin roof torn away.

At the foot of the current, the roof of a shed, full of grain, has been carried away. The body of the building, the property of Mr. Lynch, was damaged to the extent of \$300 as per estimation. On Fullum street, a brick house and a shed, property of one Louis Gauthier, have been upset at about the same time.

The Molson Distillery has been strongly shaken; some stone from the upper part having fallen.

A portion of the stables belonging to Mr. Morgan came down.

The conservatory of Viger Garden, according to one of our confreres, was very nearly being blown down by the wind, and its preservation was due to the efforts of Mr. Valtimet and his men who succeeded in propping it up. Some of its panes of glass however, were broken, and the side most exposed, was bent and distorted so much that the glazing is shaking, all the putty having been loosened. At different times, this side of the conservatory was swinging to and fro 5 or 6 inches out of the perpendicular.

One house which is being constructed on St. Lawrence Street, property of Mr. Miron, was blown down while four men were at work on it; one of them, the contractor, named Vaillancourt, received such wounds as to have to be taken to the Hotel Dieu. Fears are entertained for his recovery.

A shed, previously occupied by Mr. Taylor, St. Lawrence Street, fell down, burying two men who were not hurt.

At the corner of Lagauchetiere and Berry Streets, the cut granite gable of a house belonging to Mr. Betournay, was thrown down, and one block of stone of 5 feet, fell down from another house in progress, close to a labourer mixing mortar.

A wooden house, at Mile End, near the toll-gate, was totally upset. The same thing happened to another house on St. Dominique Street, the property of Mr. Paquette.

On the street going to the burial ground, a falling brick house was near killing a passer by. On Common Street the roof of the store of Mr. Grengan came down and missed two soldiers.

At the Gas Works a large building has fallen, wounding many persons, one of whom seriously. At Point St. Charles the action of the wind was also felt; some of the freight sheds lost their roofs. On St. Catherine Street a child had his arm broken and the face deeply cut by some falling boards coming from the lumber pile at the back of the new school for the Brothers, which the Seminary is constructing at the corner of St. Catharine, and St. Denis. A lady was also wounded.

On Sherbrooke Street a young servant girl in the service of M. McIntosh, was near being struck by a large piece of iron detached from the house.

The slender spire of the steeple of the English Cathedral was subjected to oscillations of 20 to 30 degrees, but without accident, happily.

The "Iron Duke" and the "Fashion" were driven from their anchorage; the "Iron Duke," broken in many places, was diverted on shoals, it is related. She is filled up with water, and the "Fashion" has gone to her rescue with a steam pump.

Towards two o'clock the tow boat "John Brown" steamed down in the midst of the Boucherville Islands to tow up barges that wintered there. Her captain, foreseeing the storm, remained there. Shortly after the barges were violently thrown

upon the island, and the tow boat had to get them away the next day. One of them, the "Derrick," sank. The ice has totally disappeared from the tops of wharves, but the water seems to have played havoc on them, for pieces of flooring are seen floating at many points above the water which is yet over them.

The gale was not less fatal in the country, as shown by the following letter :—

SHERRINGTON, 12th April, 1865.

MR. EDITOR,—Our poor parish has just been cruelly tried by Divine Providence. The humble temple the generosity of our people had raised to the Lord has been torn into pieces by a violent gale.

This afternoon, at about five o'clock, the faithful that were in the Church, heard a strange noise. Through the windows they could see the roof of the building going down piece by piece. At a few feet further were lying the capping and the bricks of the chimney belonging to the parsonage. On the other side were about 50 feet of the wrecked roof of our modest temple which was yet unfinished. The burial ground was covered with debris; many precious tombstones were crushed down. All these damages resulted from a north-west gale. If the wind was now turning to the north-east we have no doubt that the losses would be far greater. The remainder of the roof would certainly be blown off. Then all would be over for our ceiling, already broken at two places. We can estimate the loss at \$120.00. This sum is very large for our poor parish. We hope that Providence will not continue this trial and that we will receive grace. It is so painful to see the fruit of many years savings suddenly destroyed. But against supreme law there is no resistance.

H. A. P.

The wind blew down one of the steeples of the church at Ste. Thérèse, which falling on the roof, passed through it. It is related the roof of the church at Ste. Athanase has been removed; but we are not sure of the fact.

Portion of the roof of the church, at Ste. Scholastique, has been torn; fears, during a certain time, were entertained that the steeple would fall; but happily, it stands on a very solid framing. One piece of timber, 30 feet long, has been torn from the roof and blown in the air with an incredible rapidity.

During nearly five minutes only boards and shingles were to be seen over the church. Many sheds have been blown down. The walls of a brick house, the property of Mr. Fortin, N. P., receded many inches.

It is said, that in the parish, no less than forty barns have been damaged, some nearly completely blown down. In the adjoining localities a large number of barns and other buildings suffered alike.

The Zion Church, Toronto, and the Catholic Church, at Cornwall, lost their steeples.

At St. Martin, the bridge of MM. Delisle & Verret, called the "Bridge of la Barre à Plouffe" lost about 100 feet of its covering. Some pieces according to spectators, being thrown 21 and 30 feet.

In most of the country places, barns or houses were blown to pieces. At Pointe aux-Trembles, no less than six barns were completely broken down and many others damaged. At Longue-Pointe, two barns fell down, along the coast.

At Repentigny many houses lost their roofs. Mr. Cushing had just paid 80 to 100 men for rescuing his lumber which the ice had carried amongst the islands, when the wind forced it again in the river. One house, owned by Beauchamp, has been crushed.

At Verchères about 10 barns are down and five in Ile Bouchard.

The wind and the water, on the north side of the river, have had such action on its banks that they are eaten away some 20 to 30 feet at many places. The oldest farmers say there never was such a gale.

At Lanoraie, the shed of Mr. Champagne is down. The house of M. Latour is so much undermined that it may fall at any moment.

It is feared that between Berthier and Maskinongé great disasters have taken place. In the village of Berthier mention is made of only two or three buildings being carried

away. In the "Petit" as well as in the "Grand Nord" all the houses are said to have been carried away.

At Sorel, anchored vessels were sent adrift; a shed was upset in the dock-yard of MM. McCarthy; timber belonging to these gentlemen and others floated out into the St. Lawrence; the vessels of the Richelieu Company had great difficulties in keeping anchored in the harbour. Two or three large barges laden with wood were seen on the river resisting with difficulty to the wind.

A schooner which had wintered next to Ile Bouchard, had been loaded with firewood at Lavaltrie, and was sailing towards Montreal when she met the first touch of the gale at Repentigny; she anchored, but soon after her chain broke when she drifted down with great rapidity. Probably she came to a stand still only on arriving at the Berthier Islands.

We read in the "Courrier de St. Hyacinthe": Since Wednesday, the wind blows with an extraordinary violence. Many disasters are mentioned as having taken place during the day and night of Wednesday. A great number of trees were blown down in the adjoining bushes, the hand ball building at the college and many fences were demolished. The wind was so violent that poles of fences were thrown in the air.

#### FLOOD AND NAVIGATION.

Friday morning there was no more ice on the wharves, but a certain quantity remained on the revetment wall.

Water and ice, this year, caused incalculable damages. A man named Perrault was drowned at St. Sulpice. The bank of the river at this place is very steep and the water rose extraordinarily high, having reached a height of 8 to 10 ft. on the shore. The unfortunate Perrault, last Sunday—Palm Sunday—went for a pail of water; the bank settled under his weight and he was precipitated in the river. Efforts were made to rescue him by means of a seine, but vainly; the harpoon was unsuccessfully used; he had been buried under the fallen debris.

A letter from Sorel, dated 11th April, says:—

Water rose again 2 inches since last night. From all parts we hear but narratives of accidents and distress reigns everywhere. Yesterday a collection was taken for the relief of the poor in Berthier. The wealthiest had had no bread since a week. This morning, the principal citizens of Sorel took 300 loaves, some pork, &c., to Berthier; they crossed the river on the steamboat "Rivière du Loup," this was the trial trip of the new boat which will be used for the transport of travellers from the port of Rivière du Loup up to the mouth of the lake where the "Columbia" calls.

An idea can be formed of the elevation of the water when it will be known that entrance was effected in the Berthier church, by means of a canoe. There is no use of telling that all stores were closed and the inhabitants are in the greatest consternation.

The same persons went with the same steamer to the relief of the poor flooded people of the Chenal du Moine. Many houses have been carried away by water; others have been removed by the stream.

Well merited thanks are due to the Richelieu Company for their eagerness to put a vessel at the disposal of charitable people from Sorel in order to relieve the sufferers.

From Ste. Anne de la Pérade, a letter dated 10th says:—

"Thanks to the piers built in the river to favor the formation of an ice bridge opposite Quebec, for the greatest accommodation of that city's people and farmers around Quebec, we are favoured with a flood such as we have never had according to the memory of our oldest inhabitants.

We are literally floating. Half of the population lives in the attics of their houses; the other half have deserted their places which threaten to fall down. Cattle have been placed in the lofts of stables; some have been located on high grounds, exposed to all inclemencies; some even were drowned.

Many buildings, such as barns, stables, sheds, &c., are floating in the fields. The magnificent bridge of Ste. Anne, runs great risks of being broken; the bridge at Batiscan has been totally removed by the ice. These two bridges, the shortest having not less than 1,500 ft. in length, are almost indispensable and their loss would be an immense calamity for the public.

Happily, no human lives lost are to be recorded, but God only knows how we will get out of this ordeal. And to say that these disasters will be yearly repeated as long as the piers will be useful to the formation of an early ice bridge opposite Quebec.

Finally, a letter from Three Rivers announces that the ice of the lake has shoved during the storm of Wednesday. We could not receive details before this hour on account of the telegraph wires being broken everywhere.

“THREE RIVERS, 12th April, 1865.

“It is 2 o'clock, p.m.; the ice has been floating down in varying quantities since yesterday. At this hour, it passes abundantly. Yesterday afternoon the ice broke into the front of the office of the Richelieu Company and into the shed on Molson's wharf. The small shed on Turcotte's wharf was also crushed and part of it, as well as its roof, were carried away.

“The Messrs. Ward & Baptist have lost a great quantity of logs during the night, the booms having broken.”

“THREE RIVERS, 13th April, 1865.

Ice moved down all day, specially during the whole afternoon, under the action of a strong south-west wind. In the city, on the west side, many houses have been pulled down. Happily they had been deserted some days before, by their owners and tenants. The telegraph wire has not yet been repaired. I think the whole ice has passed. The city is in a total distress; everything is upside down. On each side of the river a great number of houses were demolished.

During the gale, a respectable inhabitant of our *banlieue* accompanied by his two sons ventured to go to his barns for looking after his cattle. Their small scow upset and they were thrown in the water. The father and the youngest son were drowned. The other son escaped a watery grave with great difficulty. It may not be the only accident to record.

THREE RIVERS, 13th April, 1865.

2 p.m.—The ice of the lake moved down yesterday. Water was very high and the wind very strong. Happily we had rain this morning; it broke the ice. Nevertheless the shoving caused great damage. Nothing was so sinister as the appearance of wrecks carried by the ice; there were parts of houses, fences, barns, uprooted trees, &c. The Farmers Hotel was very near being cut down. Seymour's house on Notre Dame Street was struck and demolished; the furniture, &c., are lost. In the *banlieue*, Mr. François Dufresne and one of his sons were drowned yesterday afternoon, while trying to save some goods off their farm. It is related that another young man was also drowned.

At Ste. Anne, according to rumour, many houses are damaged, cattle are lost, &c. On the south, the cars cannot circulate; the ice lying on the track near Godfroy river.

The Montreal and Quebec mails have not yet arrived; they are 36 hours late. Four houses, on the south, are being carried away towards the gulf.

It is said the house of Hon. M. Malhiot at Pointe du Lac, was crushed down. Telegraph wires are broken. Fences, it is related, have all disappeared, both on the north and south shores, for a space of 10 leagues.

Water lowered 30 inches, but it is yet very high. The steamboat “Ste-Anne” left this morning for Sorel.

TABLE OF FLOOD LEVELS.

The following table shows the gradual rise of the water during the flood at Montreal. The figures represent the number of feet above the ordinary level of the river :

—	Hour.	Feet.	—	Hour.	Feet.
Jacques Cartier Square .....	9.00 a.m.	19.13	Jacques Cartier Square.....	4.55 p.m.	20.24
do .....	9.06 a.m.	19.83	do .....	4.55 p.m.	20.24
do .....	3.00 p.m.	20.57	Longueuil Crossing.....	3.45 p.m.	15.83
do .....	4.45 p.m.	20.81	do .....	4.10 p.m.	15.74
do .....	4.50 p.m.	21.23	do .....	4.40 p.m.	16.12

—	Hour.	Elevation.	—	Hour.	Elevation.
Jacques Cartier Square.....	3.00 p.m.	20.57	Foot of Colborne St.....	3.35 p.m.	16.95
Foot of Montcalm St.....	3.20 p.m.	19.41	Longueuil Crossing .....	3.45 p.m.	15.83
do Voltigeur St. ....	3.25 p.m.	18.86	Military Wharf, Hochelaga....	3.57 p.m.	13.53
do Monarque St. ....	4.05 p.m.	18.49	Ruisseau Migeon .....	4.04 p.m.	13.09
do Colborne St .....	3.00 p.m.	19.50			

COMPARISON of the levels of the water, in 1861 and 1865.

—	1861.	1865.	—	1861.	1865.
	Feet.	Feet.		Feet.	Feet.
St. Peter River .....	25.00	.....	Longueuil Crossing.. .....	20.49	16.12
Above Victoria Bridge.....	24.00	.....	Hochelaga Wharf.....	19.93	13.53
Below do .....	23.48	.....	Ruisseau Migeon .....	15.85	13.07
Grant & Hall Mills.....	23.42	22.76	do (Migeon and Sauvageau)	15.85	13.09
Jacques Cartier Square .....	22.80	21.23			

“LA MINERVE,” MONTREAL, 17TH APRIL, 1865.

#### THE FLOODED PEOPLE—HELP FROM THE GOVERNMENT.

QUEBEC, 15th April.

The City of Quebec has learned with a deep regret of the misfortunes caused by the flood. The Government will not be idle and as soon as it is provided with sure data concerning the loss suffered it will help the sufferers.

The steamboat “Arctic” began this morning its trips between Quebec and Levis.

QUEBEC, 15th April.

Two miles only of the ice have gone; the ice is still solid at Cap Rouge. I believe it will resist till the next spring tide which will be only in 12 days from now.

THREE RIVERS, 15th April.

Water decreased 6 feet. Sixty buildings are said to have been carried away at Yamachiche.

## NEW LOSSES.

THREE RIVERS, 15th April, 1865.

Sufferings are great in this city. Mr. Frederic Dufresne and his son, aged 18, were drowned on Wednesday. It is said Mrs. Gingras, of Bécancour, and her family composed of six children, have been buried under the wreck of their house. Numerous accidents are related as having taken place at Bécancour, Gentilly, Berthier, Yamachiche and Pointe du Lac. In the low part of the city, 16 to 18 houses have been damaged. Furniture has been broken.

The lumber merchants who had logs in the St. Maurice Channel have greatly suffered. A woman and six children have been rescued from a drifting raft on the river. They had run two leagues.

OTHER DETAILS ON THE FLOOD—HUMAN LIVES LOST—ABOUT THREE THOUSAND CATTLE PERISHED.

THREE RIVERS, 15th April, 1865.

The operator at Berthier telegraphed to Three Rivers, on the 14th :

I have not been able to work since the 6th. Water rose to the top of my table. Yesterday it began to recede.

Nothing is heard but news of people being drowned, and houses and barns carried away.

At Chenal du Moine, three miles east of Sorel, 200 persons were rescued by the Richelieu Company.

At l'Ile de Grace, twenty persons were drowned.

At l'Ile du Pads, seventeen persons were drowned.

At Grand Nord, six miles eastward, nine houses only are standing. Hundreds of barns have been removed. No life lost. Immense number of cattle drowned. Many houses, in the village, blown down by the wind. All have suffered some kind of loss. A large quantity of grain was lost.

Everywhere we hear "This one is dead ; that one is dying."

Sixty buildings carried away at Yamachiche.

THREE RIVERS, 15, 6 p.m.

Water continues to fall.

I learn that Yamachiche is cruelly tried. Sixty buildings having been thrown down.

The M. M. Proulx, of Nicolet suffered greatly. Captain Duval, of Port St. Francois, suffered losses estimated at from \$3,000 to \$4,000.

The house of M. Malhiot, at Pointe du Lac, has not been damaged.

At Three Rivers, six drowned women and children were found.

*Another Despatch.*

BERTHIER, 15th April, P. M.  
(Via Three Rivers.)

Water continues to go down ; immense damages have been caused during these last three days ; houses broken up, barns carried away, &c. Over 60 people are supposed to have been drowned.

At l'Ile à l'Aigle, two families composed of 17 persons, were drowned.

The loss of cattle is estimated at about 3,000 head.

## PUBLIC MEETING.

As will be seen by the Proclamation of His Honour the Mayor, a great meeting of the citizens of Montreal will be held this afternoon at 3 o'clock, for the adoption of the best means to come to the assistance of the inundated people. This demonstration, due to the initiative of Mr. Justice Coursol, M.M. Lamère, McNaughton and some other citizens, will certainly attain the end for which it was called.

We learned with pleasure Saturday night, that Hon. Justice Loranger, who was one of the first to render assistance to the flooded people of the Islands and of the Chenal du Moine, will perhaps arrive here in time, to-day, to attend the meeting.

There is no use inviting Montrealers to be present at such a meeting ; their well-known charity could not be deficient on such a sorrowful occasion.

"L'Etoile," which left only yesterday morning, Sunday, had on board provisions that some charitable persons were already sending to the scene of the disasters.

We learn that M. Perreault, member for Richelieu, has taken an active part in all the measures taken in the interests of his constituents ; he himself opened a subscription list and has succeeded, it is said, in collecting a large amount.

#### THE FLOOD AT SOREL.

We have learned with much pleasure from Mr. Sincennes, that before his departure from Sorel, a Committee had been appointed to ascertain as exactly as possible the extent of the damages resulting from the flood in order to relieve each one according to his loss. We must call the public attention to the fact that last Friday Mr. Sincennes has placed "l'Etoile" at the disposition of the destitute inundated people and that he has come to Montreal for calling on public charity.

#### "LA MINERVE," MONTREAL, 18TH APRIL, 1865.

QUEBEC, 17th April.

On Saturday and Sunday some 4 inches of snow covered the ground. The ice bridge from the Harbour to the Chaudiere and the St. Charles has moved away during the flood. This flood has considerably damaged the telegraph posts on the north shore. All the houses, for a length of 6 miles, near Maskinonge, have been carried away. A schooner left for Bic to-day. The calling of a public meeting for the relief of the sufferers is talked of.

#### *Wrecks of Houses Carried on the Shoving Ice.*

Thursday or Friday, a wardrobe or *commode*, and a trunk filled with clothes of some value were found in the lower part of the parish of Contrecoeur ; besides some nice dresses, they contained nine or ten dollars in silver, a gold chain and some rings.

#### *Public Meeting in Favour of Sufferers.*

The public meeting called by His Honour the Mayor for the adoption of proper measures for the relief of those who suffered by the flood, at Berthier and Sorel, took place yesterday at 3 p.m. ; it was numerous and composed of citizens of standing, such as the Hon. MM. Quesnel, McGee, Chauveau, Ryan, DeBeaujeu, the Hon. Justices Loranger and Coursol, M. Redpath, president of the Board of Trade, M. C. S. Cherrier, M. Sincennes, president Richelieu Company, M. Lamère, general agent of same Company, M. Perreault, M.P.P. for Richelieu, and many other notables of Montreal.

His Honour the Mayor was requested to preside at the meeting and M. M. L. N. Duvernay and Stevenson asked to act as secretaries.

His Honour having read the petition which he had received and the answer he had given to same, explained in a few words the object of the meeting, which was to render assistance to the people who suffered losses by the flood. Hon. M. Quesnel then spoke on the gravity and importance of the disaster and of the urgency of adopting remedial measures ; he proposed the following resolution, seconded by Hon. T. D'Arcy McGee :—

"That this meeting regretting the calamity which has caused the death of so many persons and the loss of so much property belonging to inhabitants residing in the neighbourhood of Sorel and at Berthier, and sympathizing with the sufferers of such calamity, desire to adopt without delay, measures to relieve all those that require help, by means of voluntary contribution."

Hon. M. McGee, having seconded the motion, called to remembrance the fact that Montreal had also suffered damages by the flood, and that the inhabitants, better than others, could form an idea of the calamity which had brought mourning and desolation to such a large portion of the population of Richelieu District. He eloquently painted sorrows of those families so cruelly afflicted who, in the space of a few hours, have lost not only their wealth, their homes, but also one or more members of their household. He concluded by a warm appeal to the charity of all those present, and suggested that a subscription list be opened at once and that every one be called to contribute his share to the relief of those victims.

Hon. Justice Loranger being called to speak, said that he remembered having received the same request from Montreal, in many circumstances, and that his contribution had always been ready, but that, under the present circumstances, he had particular motives in addressing the meeting. The narrative of the flood and its ravages are to be found on papers and in the mouth of everybody, he said; no one has not been moved by the recital of such terrible disasters. A committee had been appointed at once at Sorel, to render to these poor victims, whose losses are deplored by every one, the help required. It has been ascertained that 500 persons are to-day totally ruined and have no hope of assistance other than that from the charity of the public.

The Hon. Justice then began a recital of this horrible disaster; he had seen all the facts he was to mention, or he had heard them related by the actors themselves or by those that took part in them.

For a considerable time back the rise of water excited fears of mishap; never had the river been so high. Suddenly a report reached Sorel that all the neighbouring islands were under water and the Sorel people went to those islands to assist those exposed to all the horrors of famine. No presumption could be had of what the disaster was to be. All was covered by water. Everywhere was water, 10 or 11 feet high, around buildings whose first floors were flooded. Cattle had been transferred to the upper floors of barns and stables.

Nevertheless, every one was confident and believed all danger over the moment the ice had disappeared. They were looking only for bread, and when they had received some, these poor people believed they had nothing else to wish for.

#### "LA MINERVE," MONTREAL, 20TH APRIL, 1865.

#### FLOOD—200 HOUSES PULLED DOWN AT BÉCANCOUR—LIFE LOST.

Last Wednesday while the gale was raging through the islands opposite Sorel and making so many victims, the inhabitants of Bécancour were also experiencing a terrible trial. Suddenly, at about 3 p.m., the river overflowed its banks and the water spread all over the country. The road along the river was under a depth of water, of 12 to 15 feet. The inhabitants surprised in their houses had hardly time to fly to upper floors. The ice pushed by a strong wind, crushed every thing it met. More than 200 buildings, barns and houses, have been carried away. Happily that men succeeded in rescuing people living in the most exposed places and bringing them by canoes to high places inland; had they not succeeded we would have many more deaths to record.

Nevertheless, a young child called Serene has been buried in the waves while his older brother escaped by jumping on a cake of ice whence he was rescued. A man named Dubois was at work in his barn, at the beginning of the ice shove, but the water rose so rapidly that he had to escape by a hole made in the roof and was received by four men paddling a canoe. Hardly was he in the canoe that an enormous piece of ice struck the barn and crushed it down.

A lady called Gingras embarked in a canoe with her seven children, the eldest of whom was only 15 years of age. The canoe had drifted for two leagues amidst lumps of ice and wrecks of all kinds, when it struck against an obstruction at the bottom of the river; the shock being so violent as to throw Mrs. Gingras in the water. She was

near disappearing when her daughter caught hold of her hair and succeeded in bringing her in the canoe which was kept in equilibrium by the other children. Men came to their rescue and saved them from a sure death.

The water and the ice have caused great damage. The houses and other buildings which resisted to the shove are greatly damaged. The losses to the inhabitants are immense. Two sheds belonging to one Mrs. Beauchamp have been carried away with hardware, groceries, and 200 cords of firewood. Water rose 4 feet inside of her private house and to a height of 6 feet in her store. Her furniture is no more good and her groceries having remained for a long time in the water are nearly all useless.

A letter from Maskinongé, says :

"During the débâcle of the ice on the lake, Wednesday last, 12th instant, the water of the river Maskinongé driven by a strong south-west wind invaded the fields, houses and other buildings. Many houses were destroyed and other buildings more or less damaged. Happily no life was lost. The losses of hay and other fodders were heavy. A good number of cattle, horses, beefs, cows and sheep have been drowned and carried away."

### "LA MINERVE," MONTREAL, 21st APRIL, 1865.

#### FLOOD AND DISASTER.

The "Messenger de Joliette" says :

"At Lanoraie, the gale has made terrible ravages, although no loss of life is to be recorded. Eight houses owned by Messrs. Laliberté, Ducharme, Champagne, Caron, Pagé, and by a widow, Mrs. Caisse, and a blacksmith shop belonging to Mr. Didace Lippé have been carried away by the waves. A shed of Mr. Louis Champagne's is also down. It is affirmed that this gentleman will be forced to take down his house to rebuild it elsewhere. Circulation on foot is no longer possible in front of the house owned by Notary Latour, and the ground under the south-west corner of the same house is undermined for at least 10 feet in depth. At many places, over a distance of 6 or 8 miles, the road next the river has been worn away over its whole breadth. The house mentioned as the one of Mr. Champagne is not his residence next the railway station."

"L'Ere Nouvelle" of Three Rivers, says :

"When the gale was raging most violently, the waves dashed with fury against the buildings, and in less than one hour the vast sea was covered with wrecked houses, barns, sheds and furniture passing between cakes of ice, to the great despair of their owners, some of whom risked their lives in endeavouring to save these articles. Nevertheless notwithstanding the formidable appearance of the storm which seemed to destroy all the portions of the town under water, there were only some ten houses and some barns thrown down and carried away."

### "LA MINERVE," MONTREAL, 14th APRIL, 1873.

#### THE ICE BREAKING UP.

The ice bridge opposite the city, moved somewhat during the night of Saturday to Sunday. We believe this first move of the ice is due to the actual breaking of the ice in Lake St. Louis.

The winter road to St. Lambert, has moved to below Bonsecours market. The frequent rains we have had lately contributed greatly to the shove.

News from Sorel, says the ice is shoving greatly at that place. In every part of the country the moving ice causes disasters. Since 15 years, the level of rivulets has never been so high and nevertheless the water continues to rise. The ice has piled up opposite Laprairie Village and we learn that pieces of ice are piled near the La Saline Hotel.

As it will be seen by our despatches contained in other columns, the damages done by the flood are great at Terrebonne and Sault au Récollet.

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“LA MINERVE,” MONTREAL, 15TH APRIL, 1873.

At every hour, at every instant, the progress of the shove is watched. The water continues to rise and last night it stood nearly 2 ft. high in most of the cellars of the stores of St. Paul Street, between McGill and St. Peter Streets. Some cellars on Commissioners Street are also flooded. At many places the ice has moved on top of the revetment wall on Commissioners Street, and nevertheless it is only the beginning.

If we go through Point St. Charles, we notice that the inhabitants are very uneasy and do not know what will be the end of what is called the “*débâcle*.” The water in certain parts of that suburb, especially on the south side of Wellington Street, is 4 to 5 ft. high.

Above Victoria Bridge, the ice pilings reach 25 ft. in height. The ice packs are seen all around Ste. Helène Island and some of the pine trees which are its ornaments, in summer, have been crushed. Old inhabitants say they never saw the like.

At Longueuil, fears are entertained the same as on this side; people are preparing for the flood. Two men yesterday crossed the bridge to St. Lambert, but it is said they have incurred great risks and that they would not repeat the same imprudent act.

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“LA MINERVE,” MONTREAL, 18TH APRIL, 1873.

The ice bridge has shoved down a little during the night of Wednesday to Thursday, especially on the St. Lambert side; on the south side of Ste. Helène Island, the ice has piled at several places, to a height of 50 ft., forming mountains.

Many guns mounted on their carriages and used for firing practice have been pulled down.

Water rose rapidly since 10 o'clock the night before last. Yesterday morning, Commissioners Street was flooded, partly, between St. Jean Baptiste Street and Bonsecours market.

The warehouse “Ottawa and Rideau” and the coal yard of the Intercolonial, on McGill Street are flooded, as well as St. Paul Street at the corner of St. Peters Street, and a great portion of Pointe St. Charles including the plot of land known as “St. Patricks Fields.” Cellars in Griffintown are flooded; last night Chaboillez Square appeared like a small lake. Portion of St. David Street has been changed into a rivulet.

At Point St. Charles many inhabitants use canoes for going out of their houses.

Lands situated on the Lachine road are covered by 3 to 4 feet of water. The ground floor of St. Anne's Market is full of water. The winter road to Longueuil is totally broken up and enormous pieces of ice have got stuck fast near the cotton factory, at Hochelaga.

At four yesterday morning the steamer “Richelieu,” of the Richelieu Company, left Sorel for St. Hilaire. The passengers arrived here by the noon train.

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“LA MINERVE,” MONTREAL, 19TH APRIL, 1873.

The water which is now at the level of top of the revetment wall, seems to be stationary. Since 4 p.m. yesterday, Commissioners Street is dry, though some pools of water are yet seen in some places.

It is related that some time yesterday the Village of Laprairie was totally flooded and that great damages were caused by ice; it is even said that many houses were torn down. M. Lanctot, hotel keeper, seems to be the greatest sufferer of all these accidents.

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“LA MINERVE,” MONTREAL, 21ST APRIL, 1873.

Water has reached an extraordinary level; it stands over all the wharves and threatens to invade the offices and sheds of the Richelieu Company, the highest on the shore,

to which access is now had by boards resting on blocks. Our rich harbour has at last been entirely cleared of its winter obstruction—the ice bridge. At the first shove of the ice heavy chains which tied to shore some rafts of square timber were broken as threads, and the rafts moved down a distance of fifteen arpents. One crib even followed the ice in the river. All the remainder were saved. This was the only accident due to the breaking up of the ice.

“LA MINERVE,” MONTREAL, 23RD APRIL, 1873.

A large quantity of ice lying on the shore at St. Lambert, moved away yesterday. At Longue Pointe the breaking up of the ice is far advanced, and a channel is opened as far as beyond Verennes.

The water is falling slowly.

(*Morning Chronicle, Quebec, 12th April, 1865.*)

INUNDATION AT STE. ANNE.

A correspondent writes us as follows : from Ste. Anne de la Pêrade, under date of Sunday :—

“We are flooded. The water was never so high here as it is at the present moment. There is a foot of water in the lower part of the house in which I at present reside, although it is built in the highest part of the parish. I have been obliged to take my horses out of the stable. To day we went to church in canoes. It is feared that the water will rise still higher, inasmuch as the ice is not moving. All the fields in rear of the village are flooded as far as the woods. Fears are entertained for our bridge, inasmuch as the ice is jammed against it. It is said here that Batiscan bridge has been carried away, and that a number of small craft, in winter quarters at the mouth of the river, have been damaged. Our own parish presents a sad spectacle. Its whole extent is inundated as far as the church.

The Montreal “Evening Telegraph” of 12th April, 1865, says :—

The flood still continues with little abatement, and although the water is not so high as in 1861, the area of the submerged district is very large, extending from the river to Bonaventure Street, including the whole of Ste. Ann’s, part of St. Antoine, West, Centre and East wards. The amount of suffering occasioned by it is very great, and quite beyond the means of the national and other benevolent societies to alleviate.

(*Morning Chronicle, Quebec, 13th April, 1865.*)

THE ICE PIER.

A correspondent of the “Journal,” writing from Ste. Anne de la Pêrade, in reference to the flood at that place, already referred to in our columns, says :—

“Thanks to the piers constructed in the river to favour the formation of an ice bridge for the accommodation of the citizens or persons residing in the environs of the city, we are now in a “jam,” the like of which was never seen before within the memory of man.

“There is but one outcry here, a protest against the piers and those who caused them to be constructed.”

(*Morning Chronicle, Quebec, 15th April, 1865.*)

THE RIVER.

By the latest intelligence received we learn that the ice that broke up in the upper part of the river has got jammed at Grondines.

The damage done to Mr. Cushing’s mill at Repentigny, by the recent break up of the ice, is estimated at \$200.

(*Morning Chronicle, Quebec, 19th April, 1865.*)

The ice has done much damage at Bécancour and Gentilly, while full details of the disaster at Pointe du Lac, have not yet reached us. In the lower part of Three Rivers there are fifteen houses more or less injured by the ice, and in many instances the furniture has been either carried away or else broken to pieces. The high water has also caused loss to several lumber merchants who wintered saw-logs and timber in booms in the east channel of the St. Maurice. The flood rose above the piers to which the Government booms are usually attached, and the ice floated over them carrying off most of the timber and logs wintered there. In a similar way the water in the west channel of the St. Maurice rose so high, being backed up by the St. Lawrence, that the ice floated over the piers belonging to Mr. Ward's sawmill, and when the gale of Wednesday rose, the entire sheet of ice from the mills to the bridge was carried out half way across the river, bearing with it, the booms which had been strung along inshore in the fall for safety, as well as boats, schooners, etc. Fortunately there was no current in the St. Maurice, and by dint of hard labour and considerable expense all the property will be saved. A gentleman who had occasion to pass through Belle Rivière, St. Eustache, St. Martin, informs us that he counted no less than 32 barns and 4 dwelling houses unroofed during the gale, also that the covering of the bridge of Barre à Plouffe was to the extent of about 150 yards blown into the river.

One of the incidents of the disaster at the Island of Sorel is thus described: "One child of twelve months old had been taken off a roof by Capt. Labelle and was supposed to be dead, but by constant rubbing when on board by the crew of the boat, he was brought to life. One young woman, thinly dressed, dripping wet, with long hair dishevelled, hanging over her face and shoulders, with large black eyes rolling, presented a picture of despair, she looked as if bereft of reason. One very old man and a number of women and children were driven away in an open boat towards the lake; fortunately they found refuge in a covered bateau, which was itself driven into the woods. The husband of one of these women caught hold of some boards, was carried in another direction into the woods and passed twelve hours in that situation. One man left his house to go to the barn to feed his cattle; a few minutes after he saw his house fall. His wife and three children were drowned.

The following additional sad tidings come from Isle du Pads: Three houses were knocked down, and, with their contents, were carried away by the force of the wind and water. Seventeen persons were lost, namely, the wife of Oliver Berard and four daughters; widow (Gilbert Brisset and her children) Jos. Boucher and his wife, and the wife of another Jos. Boucher. Besides these victims, two other persons, the wife of Louis Deay and his daughter were carried away by the flood, but they were subsequently rescued and it is hoped that they will recover. Sixty buildings have been destroyed at Yamachiche. At a place called Grand Nord, six miles below the Isle du Pads, there are only nine dwelling houses standing. Every barn and outbuilding has been carried away. The number of cattle drowned is immense. The Messrs. Proulx at Yamachiche have suffered very heavily. Captain Duval's loss at Port St. François will reach \$4,000. At Isle de l'Aigle two families, numbering seventeen persons, were drowned on Friday night.

A frail craft on which there were seven persons, a mother and six children, were picked up below Berthier by one of the steamers. They were terribly exhausted, having drifted down some six miles with the current. The total number of deaths is stated by those who have visited the inundated district at fifty or thereabouts, and the destruction of the other sufferers who escaped with their lives is in many instances extreme.

The number of cattle drowned is estimated at three thousand head at least.

(*Morning Chronicle, Quebec, 20th April, 1865.*)

The following extract of a letter from Nicolet, under date of Monday last, has been communicated to us for publication:—

"Great damage done here by the water, ice and wind. The buildings on the property belonging to Mr. Gleason suffered great damage. A large dwelling house was all smashed with the exception of the frame which was left standing.

"The barns, stables and other outbuildings, to the number of nine or ten, were either thrown down and carried away by the water or smashed to pieces. All the fences are gone and trees torn out by the roots. Mr. Michael Finlay, the tenant of the said property, has suffered great loss, having lost all the grain to the amount of 300 bushels, also 1,500 bundles of fodder. All the farm implements have been carried away, not an article left. Mr. Roy, of Nicolet, has also had his barns destroyed and his house considerably damaged. Mr. Boudreault has likewise suffered heavily, his house having been destroyed. Mr. G. Beaubien and other residents have suffered more or less."

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*(Morning Chronicle, Quebec, 27th April, 1895.)*

Some additional details have been received of the loss of life and property at various points on both banks of the River St. Lawrence, by the recent flood storm. The bodies of nineteen of the victims, belonging to the de Grace and Isle du Paradis, have been picked up along the shores. The greater number of these are women and children. The loss of property in the parish of Nicolet is estimated at \$12,000. The loss at Beauceville is much more extensive than was at first supposed, about three-fourths of the whole surface of the parish being flooded. Fully two hundred buildings in this locality have been carried away, and the loss of cattle, grain and produce generally is immense. At Lamorne, which it was thought at first had escaped the dreadful visitation, eight dwelling houses and a number of outbuildings were carried away, but there was no loss of life.

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APPENDIX No. 20.

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REPORT ON WATER LEVELS, RIVER ST. LAWRENCE, BETWEEN QUEBEC, MONTREAL AND  
LACHINE, BY R. STECKEL, CIVIL ENGINEER, 24TH NOVEMBER, 1891.

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NOTES AND REMARKS

RELATIVE TO THE

DÉBÂCLE AND THE FLOODING OF THE BANKS

ON THE

RIVER ST. LAWRENCE

BETWEEN

QUEBEC, MONTREAL AND LACHINE

IN THE

SPRING OF 1887.

Replies of mayors, municipal officers, etc., of riparian parishes to circulars  
sent by the Department of Public Works at the approach  
of spring in 1887.

LAPRAIRIE, 23rd April, 1887.

G. F. BAILLAIRGÉ, Esq.,  
Deputy Minister of Public Works,  
Ottawa.

SIR,—I have the honour to acknowledge the receipt of your communication dated the 20th, by which you ask me to observe the shoving of the ice and generally all other particulars relating to the débâcle on the St. Lawrence.

The following day I commenced my observations and I hope before long to be able to present you with a complete report, not only of my own personal observations but also of those of Rev. Mr. Bourgeault, the parish priest, who has noticed with particular attention the movements of the flood, as well as those of citizens of good standing of this village.

I have also followed the instructions contained in the dispatch of Mr. A. Gobeil, dated the 26th instant. The highest level reached by the water is marked on the break-water. So that you need not fear, dear sir, that the information will be deficient, but rather, a superabundance of data.

Warmly thanking you for the interest you display in favour of La Prairie. I remain with much consideration

Your obedient servant,  
(Signed) T. A. BRISSON.

LONGUEUIL, 28th April, 1887.

G. F. BAILLAIRGÉ, Esq.,  
Deputy Minister of Public Works,  
Ottawa.

SIR,—In answer to your request dated the 20th instant asking for information concerning the progress of the ice shove and the flood this year, at Longueuil, I have the honour to submit the following observations :

From April the 18th to 21st, the water stood nearly at a uniform level, viz : even with the foot of the streets ending at the bank of the river without, however, flooding the said streets.

In the morning of the 22nd at 6.15 the ice shoved with great effect along the bank, from the government land, at the west end of the city, causing the formation all along the bank of a wall measuring on an average 24 feet in height, breaking the house and barn situated on the government land ; carrying away one corner of the house belonging to the South-Eastern Railway Company : destroying part of the property of Mr. Smardon, near the river, on the street opposite the convent of the "Sœurs Jésus-Marie" and causing further damages of less importance. At the same time water reached the foot of St. Charles Street in the west end of the city, rising about 3 feet, but it fell almost immediately to within 1 foot of its level prior to the shove.

In the afternoon of the 22nd, at 5 o'clock, water rose very slowly. At 5 p.m. I paid a visit to the waterworks, and it was noticed that the water was only a few inches below the fires. I then went by boat to the ruins of the government farm house to have a good view of the situation.

On the Montreal and Hochelaga side, and behind Ste. Hélène Island, I could see but mountains of ice following a line nearly direct from the South-Eastern Railway to the cotton factory of Mr. Hudon. Below this point, the ice seemed not to have moved, except along the bank of the river and along the city front as above referred to. I found the situation to be so threatening that I ordered the men in charge of the waterworks to take every possible measures to prevent the fires being put out, but not to remain on the premises during the night for fear of the works being washed away by ice that could be driven against the building during that period. From 5 to 6 p.m. the water rose more particularly in the west end of the city, and we noted that it was not so much the swelling of the St. Lawrence itself, as the waters running down from St. Lambert which flooded our streets. At 8 o'clock, water rising slowly in the east end of

the city. The ice seemed jammed and securely anchored to the bottom of the river where the Montreal Harbour Commission have deposited the dredgings of the said harbour during the past few years, and more particularly from the Princess Royal Avenue down towards Boucherville.

23rd April, 6.30 a.m. Thermometer 48°. South-east wind. The water rose about 1 foot during the night and covers a part of St. Charles Street, but does not reach the fires of the boiler in the waterworks. Ice does not seem to have moved during the night.

Noon. Temperature 55°, south wind. Threatening rain. No rise in the water, which is at the level of this morning. Ice opposite town has not moved. I learn by telephone that in Montreal the water has fallen 6 inches.

5 p.m. Heavy rain. No change in the condition of ice since noon. I learn by telegraph from Pointe-Claire that the ice of Lake St. Louis was yet solid at 2 this p.m.

8 p.m. Water has risen a little since 5 o'clock, which is due as much to rain as to the ice. The stretch of the river between Victoria Bridge and Laprairie which was free of ice this morning has been refilled for the second time since yesterday. The rain has changed the rivulets into torrents.

24th April, 6 a.m. Temperature 40°. Water rose 4 inches in the west end of the city and 10 inches in the east end. No noticeable change in the state of ice.

9 a.m. No particular observation. Water has only 1 inch more to rise to reach the fires at the waterworks.

Noon. No change to be noted.

1 p.m. I learn by telephone from Pointe Claire that the ice began to move. We expect a shove here at about 6 p.m.

3.40 p.m. Beginning of the débâcle. The ice, at the back of St. Helène Island, south shore, descends towards the north, but once at the centre of the river, flows towards north-east as far as opposite the Catholic church of Longueuil and thence directly to the east till it grounds on the bottom covered by the dredgings deposited by the Harbour Commissioners.

For one hour the water rose very rapidly and reached from 18 to 19 inches above the highest water of 1885, which was the highest flood observed in Longueuil, that of 1886 having reached a level 1 ft. lower.

From 3.40 to 4.30 water rose at least three feet.

5.20 p.m. Water fell 6 inches. The ice shove is stopped, but we expect there will be another move at about 8. Seen from the steeple of the church the part of the river between Victoria Bridge and Laprairie seems to be free of ice.

The engines at the waterworks are not working. The ice has not moved at the eastern end of the town. It seems as if the ice shoved further down on the south shore probably because the Montreal Harbour Commission has not placed any obstructions to the free course of the ice on that side of the river.

6 p.m. Water stationary. Ice not moving. Thermometer showed little or no change to-day, not having risen above 42°. This morning we had 40° at 6 o'clock, now we have 40½° at 7 p.m.

Since one hour, water has again fallen by 6 inches. No change in the ice.

25th April, 6 a.m. Temperature 32°. During the night the water fell some inches. It stands about 1 foot lower than the highest level reached yesterday at 4.30. It rose a little between 8 o'clock and midnight, for this reason the three decreases of height I point out, viz.: that at 5.20 p.m., that at 7 p.m. yesterday and that of this morning. I find a fall of only 1 foot. No change in the ice on the Longueuil side. The key or centre of resistance seems to be in the eastern end of Longueuil towards Boucherville.

9 a.m. A dispatch from Pointe Claire says the ice of Lake St. Louis is coming down in one field. No change to be noticed here in the ice.

1 p.m. No change.

26th April, 7 a.m. During last night water fell about 12 inches. No change in the ice.

Noon. Water decreases very slowly in height.

6 p.m. Water level decreased about 1 foot in the preceeding 12 hours. No change in the ice. I have given orders for marking the highest elevation reached by water, from the waterworks to the lower part of the town, so as to refer to these marks when required.

27th April, 6 a.m. Thermometer 36°. No motion of the ice and no change to be noted.

Water level decreased sufficiently to permit the working of the pumps of the water-works this morning.

Noon. During the last 18 hours water fell 1 foot. We begin to realize the extent of the losses suffered which are greater than at first supposed.

The habitants on the north of St. Charles Street are totally demoralized. The exasperation against the Montreal Harbour Commission is at its height and the calling of an indignation meeting is talked of as also the sending of delegates to make representations to the Federal Government, with a view of obtaining justice from the said Commission who seem inclined to sneer at every one, notwithstanding that it is evident the Commission is responsible for the present state of things by its perseverance in filling up the channels below this town.

28th April, 6 a.m. Thermometer 35°. No change in ice. Water is still falling. The eye cannot ascertain the opening of a channel within the range it can reach.

6 p.m. Channel opened on the Hochelaga side and ice moving down, but at the east end of the town, towards Boucherville, it moves very little if any. This is a very excellent opportunity for the Engineer of the Montreal Harbour Commission to come and admire his work. The year 1887 will be memorable for Longueuil when the flood question will come up.

I have the honour to be, Sir,

Your devoted servant,

Signed, L. E. MORIN.

*Mayor of Longueuil.*

LONGUE POINTE, 22nd May, 1887.

SIR.—In answer to your request concerning informations in relation to the flood and the damage, I have to say that the ice moved between Hochelaga and Longue Pointe on the 22nd April, the water was excessively high at the beginning of the above; on the 24th the ice moved anew from Longue Pointe to the end of Charron Island, the water decreased in height during these few days; for a third time, on the 27th, the ice moved, and between 4 or 5 o'clock on the afternoon of the 29th the river was entirely clear.

I believe we were exempted from a flood at Longue Pointe only on account of the ice having begun to move below this place. As regards the height reached by the water, it did not rise as high as during the floods of 1885 and 1886.

Signed, HORMIDAS LAPOINTE.

REPENTIGNY, 5th May, 1887.

SIR, I am directed by the Mayor of this place to transmit to you the following informations concerning the flood at Repentigny.

This year it is impossible for us to tell you exactly the greatest height through which the river rose on the 24th April 1887 at its maximum, because we have not observed the height of the water last summer when it was low. However, we can say that we believe the water reached a point 20 ft. above the lowest water. The point it reached this year was 20 inches lower than that of last year.

Since 3 years, the water covers the two-thirds of the Post Road for a depth of 1 to 6 ft.

The débâcle began at 4 a.m. Wednesday, the 27th April, and was very slow ; 4 days before the river was clear of ice opposite this parish. As everywhere else, the water rose and fell a few inches in one hour, &c., &c.; but it remained high during a shorter time this year than last.

The flood of this spring lasted from the 20th April to the 1st of May.

I have the honour to be, Sir, your obedient servant,  
(Signed) F. X. O'BRIEN,  
Secretary-Treasurer of the M.C.P.R.

G. F. BAILLAIRGÉ, Esq.,  
Deputy Minister of Public Works,  
Ottawa.

#### CONTRECEUR POST OFFICE, 30th April, 1887.

The Mayor of Contreœur, Jos. Duhamel, has the honour of answering to a circular of the Deputy Minister of Public Works, dated the 20th April, as follows :

The river reached its highest level at noon of the 25th and stood  $2\frac{1}{2}$  feet below its highest level of 1886. The absence of a water gauge prevents us from giving a more precise figure. After many moves, the ice made a decided downward move on the 28th at noon, and continued to descend thereafter. On the 29th, the Northern Channel seemed free of ice.

The breaking up of the ice opposite our place is always slow and difficult on account of the narrow passage in front of Lanoraie.

It is said the river is free at Verchères. Large quantities of ice are yet kept back here by the islands, and a strong north-east wind.

(Signed) JOS. DUHAMEL, Mayor.

#### LAVALTRIE, 5th May, 1887.

SIR,—I have the honour to transmit herewith my notes and observations concerning the breaking up of the ice and the flood of this spring at Lavaltrie.

I considered that I should supplement these notes with certain remarks, which being in accordance with others, will, I hope, help the Government not only in finding the remedy, but also to apply the said remedy to our sufferings. Let us have the proper confidence in engineers, for the most part strangers, who know very little of our great river ; but specially let us listen to the testimony of old Canadians able to supply informations based upon their own experience, and which are worth a great deal more, I think, than the reports of those engineers made at the cost of millions of dollars.

I have the honour to be, Sir, your obedient servant,  
(Signed) SIM. MARTINEAU, M.D., Mayor.

G. F. BAILLAIRGÉ, Esq.,  
Deputy Minister of Public Works,  
Ottawa.

#### NOTES AND OBSERVATIONS ON THE DÉBÂCLE AND THE FLOOD AT LAVALTRIE, 1887.

Friday, 22nd April. The water which up to date has risen slowly, is yet 8 ft. below its highest point of last spring, 1886.

Saturday, 23rd April, 6 a.m. Water rose 2 ft. since yesterday. This morning a shove of the ice took place ; ice moved for about 200 ft. and broke the shed of the Richelieu Company.

Sunday, 24th April, 6 p.m. To-day, water rose 6 inches. Three feet more required to reach the level of last year.

Monday, 25th April, 3 p.m. Water sank 2 inches since yesterday.

Tuesday, 26th April, 4 p.m. Water fell 8 inches since yesterday. Ice yet solid.

Wednesday 27th, 8 p.m. Water is again sinking a little. Ice began to move last night and is still piled up at several places on the banks : many fences broken and carried away.

Thursday 28th, 9 a.m. Ice shoves again and breaks up here and there. Water descends slowly.

28th April, 6 p.m. At various intervals to-day, the ice went down and broke up, we began to notice a few open spaces here and there.

Remark. The rise of the water is explained by the ice choking the narrow part of the river in front of Lanoraie. This jamming of the ice at Lanoraie, in 1869 and 1886, after the departure of the ice from opposite our place, caused the water to reach here its highest level : it could not flow through the choked channel. Sometimes, however, the jamming takes place amongst the Islands of Sorel, instead of at Lanoraie, and which equally causes a flood at Lavaltrie, such was the case in 1865 and 1885.

29th April, 6 a.m. This morning the channel is nearly clear of ice, although ice is yet solidly attached to the shoals, on each bank. Since yesterday, water fell  $1\frac{1}{2}$  ft. and the action of the wind is the only cause that can now detach these grounded cakes of ice.

Remark. It is proper to state that since a few years, the Montreal Harbour Commission has caused a new channel to be dredged across the flat shoals, on the south side of the old channel. This new channel, according to the opinion of competent men, corroborated by the testimony of an experienced pilot, living here, is one of the most active causes of the flood, and I am of the same opinion. At any rate it is worthy of note that this channel is opened since only three or four years, and that during each one of these years, we have experienced a disastrous flood.

This opinion is based upon two principal reasons : 1st. The level of the shoals has been considerably raised by the deposition of a large quantity of dredgings here and there.

The dredging operations have caused these shoals to dry at low water, whereas they were never seen above water before. Whence : a first obstruction, easy to understand, opposed the descent of the ice. 2nd. This new channel has completely changed the natural course of the river which followed the old channel in a straight direction towards Lanoraie. Now the water has to turn nearly at an acute angle up stream to go into the new channel which is deeper than the old one, where the banks are nearly dry at low water, which gives the channel the appearance of a canal. The water goes through that channel as through a rapid, for a distance of 3 miles, and strikes in a perpendicular direction on the banks at Contrecoeur. In thus striking the shore, this stream is broken up and reflected so as to return northward, stemming back the surrounding waters on each side. Whence the dangerous whirlpool complained of by pilots and which causes the ice to ground on the adjoining foreshores and thus obstructs the river bed more and more : the original current being no longer there to clear it.

Nothing surprising then, if we have floods, and we will have many more of them in the future, because, these are undeniable facts which everybody can ascertain and the consequence of which can only be more and more disastrous floods.

29th April, 6 p.m. Strong north-east wind. Water rose one foot since morning. The fields of ice, grounded on the shoals, are broken up by the action of the tide.

30th April. Moderate wind : hardly any ice left. The water continues to fall steadily, the flood is over.

Remark. The highest level was reached here by the water on the 24th April. It stood 3 ft. below the level of last year, and one foot below the level of 1885 : in 1869, the flood reached about the same level as this year.

As far back as our people can remember, the highest flood observed here was that of 1886.

1st May, 1887. Opening of navigation.

(Signed) SIM. MARTINEAU, M.D., Mayor.

Lavaltrie, 1st May

BERTHIER EN HAUT, 3rd May, 1887.

G. F. BAILLAIRGÉ, Esq.,  
Deputy Minister Public Works,  
Ottawa.

SIR,—In answer to your request addressed to me asking for information concerning the breaking up of the ice at Berthier, I supply you with the following notes.

The débâcle occurred on the River St. Lawrence, opposite this place, on the 29th April. The greatest rise of the water took place on the evening of the 24th, when it reached an elevation of  $16\frac{1}{2}$  ft. above its ordinary summer level; the low part of the town became flooded on or about the 15th April, and the whole town on the 24th. Late in the evening of that day, the water became stationary, and remained so all night and during the forenoon of the 25th, after which it began to fall quite rapidly, and during the whole of the 25th, and since last night, it recedes slowly enough—the low part of the town is yet somewhat flooded. The water rose very rapidly during the night of the 23rd to the 24th, and during this last day.

According to many observations, there is a difference of 10 inches or thereabouts between the level of the water in 1865 and this year's, noting that the flood of 1865 is stated to have been the highest by the oldest habitants; and that the flood of 1887 comes next as regards elevation.

I remain, Sir, yours, &c.,

(Signed) F. O. LAMARCHE,  
Mayor of Berthierville.

ST-FRANÇOIS DU LAC, 4th May, 1887.

G. F. BAILLAIRGÉ, Esq.,  
Deputy Minister of Public Works.

SIR—,The following is my answer to your request:

On the 29th April, lake St. Peter and the river were cleared of ice.

The flood commenced on the 14th of that month and the water has not yet altogether gone down.

This year the water rose 4 ft. higher than last, and I have marked its highest level of this year on a house, as I was requested.

(Signed) H. CREVRIER, Mayor.

ST-FRANÇOIS DU LAC, 18th May, 1887.

SIR,—In reply to your letter of May the 12th, asking me to give you the date of the breaking up of the ice on River St-François du Lac, I have much pleasure to be able to inform you that it took place on the 27th and 28th April; water was nearly 2 ft. higher than during other springs.

It commenced to fall on the 26th, and now, is at its normal height.

I have not asked for information from the Mayor of St. Thomas, because this gentleman lives in the concessions, and I think he has not heard of this question of flood.

Your most humble servant,

HENRI CREVRIER, Mayor.

G. F. BAILLAIRGÉ, Esq.

YAMACHICHE, 28th April, 1887.

Mr. A. GOBEIL,  
Secretary of Public Works,  
Ottawa.

SIR,—I received your telegram and in answer thereto, beg to state, that I acted according to your request in marking the highest level reached by the water this spring.

Yours truly,  
(Signed) THOMAS DUFRESNE, Mayor.

CHAMPLAIN, 28th April, 1887.

G. F. BAILLAIRGÉ, Esq.,  
Deputy Minister of Public Works,  
Ottawa.

I have received your letter of the 20th instant, asking for information relative to the highest water and the breaking up of the ice.

The water rose  $18\frac{1}{2}$  ft. above the summer level of the lowest tides. The débâcle began in the afternoon of the 20th, and the ice continued to move every day until Sunday morning the 24th, when the water began to fall, and since then it fell  $5\frac{1}{2}$  ft.

I remain, your most humble servant,

(Signed) XAVIER BOURBEAU, Mayor.

GRONDINES, 25th April, 1887.

G. F. BAILLAIRGÉ, Esq.,  
Deputy Minister of Public Works.

SIR.—Ice broke up here on the 24th inst., at 6 a.m. : we had no flood : water rose about 8 ft. during a few hours only.

I have the honour to be, Sir, your humble servant,

(Signed) ONÉSIME RIVARD, Mayor.

ST. ANTOINE, 15th May, 1887.

SIR.—At different times, I went to the river to note the highest level reached by the water : and it is in April that it rose most. I have marked its level on a shed,  $\frac{1}{4}$  of a league below the church.

(Signed) N. DION, Mayor.

STE. CROIX, 27th April, 1887.

MR. A. GOBEIL.

In reply to your telegram of yesterday, I have to ask you if I am to observe all the highest spring tides, or only those that will rise most and no others. An answer is requested.

Yours truly,

CAPT. FERD. BOISVERT, Mayor.

No. 76890.

ST. LAMBERT, 5th May, 1887.

To the Deputy Minister of Public Works, Ottawa.

DEAR SIR.—In conformity to your request, I herewith submit the following facts in relation to the recent flood and its results on this side of the river.

A shove took place on the 20th day of April, about 3 o'clock in the afternoon, and a large quantity of ice shoved up on Moffatt's Island, this turned the course of the shove, crowding it towards the St. Lambert shore, causing considerable damage to the river bank, by removing large quantities of soil therefrom. The water rose slowly until about noon of that date, and at this time it reached the height of about 23 feet above summer level.

On the morning of the 22nd it commenced to recede slowly.

The water at its highest stage measured from 2 to 6 feet above the road, and in some parts it shoved the ice up to a height of from 15 to 20 feet and quite close to a large dwelling house. Had the ice gone a little further it would have been wrecked.

and in other parts large boulders have been deposited in the middle of the road. The ice has this year, as it did during the flood of last year, removed a large part of the river bank, below the long wharf, formerly used by the G. T. R.R., but of no use now; the road has now become so narrow in consequence of the removal of so much of the river bank, that it is dangerous to public travel, the road being in some places only about 15 feet wide, and two teams can hardly pass with safety.

It is to be hoped that the Government will take measures to remove this wharf. It would furnish excellent material for the improvements so much needed on the St. Lambert shore.

The shove took place on the afternoon of the 24th, at this time the bulk of the ice left here and the water lowered some, but owing to the clamming of the ice gorge below Longueuil the water continued even with and the lower parts several feet above, the road, until the 27th, when it left the road altogether.

I think with many others that the Harbour Commissioners have committed a grave mistake in causing the dredgings of the harbour to be dumped in the river, below Longueuil, thus causing shallows for the great mass of ice to ground on, and prevent the free flow of the water.

In conclusion I would say, that these floods are causing great loss of property and the people's time, besides the untold miseries and suffering brought upon the inhabitants of the flooded districts. We hope that such measures may be adopted as will hereafter put a stop to these inundations.

Respectfully yours,

(Sgd.)

M. CRAIG,

*Mayor of St. Lambert.*

No. 76665.

HARBOUR MASTER'S OFFICE,

MONTREAL, 2nd May, 1887.

DEAR SIR,—I am in receipt of your note of the 21st ult., and send you by mail, a copy of our annual report, in which you will find statement of the opening and closing of navigation from 1877 to 1886, as well as other information that you may find interesting.

Believe me, yours very truly,

(Sgd.)

THOMAS HOWARD,

*Harbour Master.*

G. F. BAILLAIRGÉ, Esq.,  
Ottawa.



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## APPENDIX No. 21.

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REPORT ON WATER LEVELS, RIVER ST. LAWRENCE, BETWEEN QUEBEC, MONTREAL AND  
LACHINE, BY R. STECKEL, CIVIL ENGINEER, 24TH NOVEMBER, 1891.

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### NOTE A.

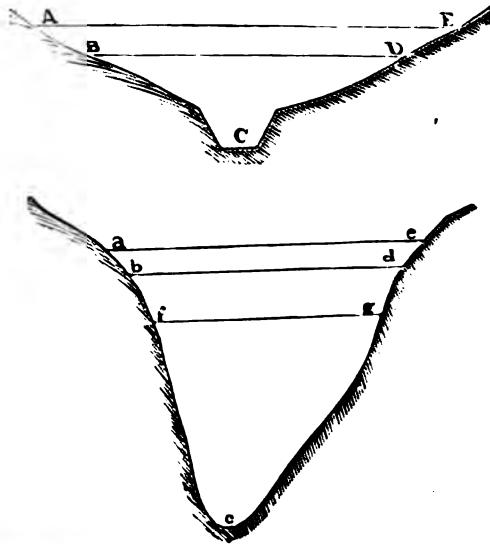
APPROXIMATE DETERMINATION OF MEAN LEVEL OF ATLANTIC  
OCEAN, AT QUEBEC, BY MEANS OF DATA AFFORDED BY TIDE  
AND RIVER GAUGE REGISTERS KEPT AT VARIOUS  
PLACES BETWEEN QUEBEC AND MONTREAL,  
1878 TO 1882; THE ADMIRALTY  
CHARTS, Etc., Etc.

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## NOTE A.

APPROXIMATE DETERMINATION OF POSITION OF MEAN LEVEL OF  
ATLANTIC OCEAN AT QUEBEC, BY MEANS OF DATA AFFORDED  
BY TIDE AND RIVER GAUGE REGISTERS KEPT,  
1878 TO 1882, Etc.



1st. Let A B C D E A be a cross section of Lake St. Peter, or at any other point of the River St. Lawrence, where it is free from regular tidal fluctuations, or practically so, in comparison to the variations of level due to changes in the fresh water discharge, and where the elevation of the bottom of the thalweg is near a maximum and the bed would be completely uncovered if the stream ran dry at any time; the surfaces A E and B D corresponding; respectively, to river levels 26.6 ft. and 20 ft. above 0, per Montreal Harbour Commissioners' gauge at Sorel.

2nd. *a b c d e a*, a cross section of the St. Lawrence estuary—such as it would be, if the Atlantic Ocean; being abstracted from the combined influences of the sun and moon, was tideless—at a point where the depth of the back water from the sea at its mean level is great in comparison to the total depth of the stream of drainage and tide water which makes its way to the gulf; the surfaces *a e* and *b d* also corresponding to the river levels at Sorel just described.

Again, let us put:

$F_1$ , for area of waterway	A B C D E A,
$F_2$ , " "	B C D B,
$F_3$ , " "	<i>a b c d e a</i> ,
$F_4$ , " "	<i>b c d b</i> ,
$p_1$ , for wetted perimeter	A B C D E,
$p_2$ , " "	B C D,

$C_1$ , velocity in waterway	A B C D E,
$C$ , " "	B C D B,
$c_1$ , " "	$a b c d e$ ,
$c$ , " "	$b c d b$ ,
$Q_1$ , volume of water passing through area	A B C D E A = $F_1$ , in the unit of time,
$Q$ , " "	B C D B = $F$ , in the unit of time,
$Q'_1$ , " "	$a b c d e a = F'_1$ ,
$Q'$ , " "	$b c d b = F'$ .

Neglecting to take into account the comparatively small quantities of water supplied by the affluents of the St. Lawrence, between the cross sections selected and above described, viz., A B C D E A and  $a b c d e a$ , we may consider the volumes which flow through the same in the unit of time to be sensibly equal to each other and admit that :

$$Q'_1 = Q_1 \text{ and } Q' = Q \quad (1)$$

But although not invariably true within narrow limits, still it is probable that on the same river bed the velocity  $C$  varies, in general, nearly as  $\sqrt{F}$  whence we may put :

$$\frac{C_1}{C} = \sqrt{\frac{F_1}{F}} \times \sqrt{\frac{P}{P_1}} \quad (2)$$

As each one of the volumes ( $Q, Q_1$ ) is evidently equal to the product of the area ( $F, F_1$ ) by the velocity ( $C, C_1$ ), we have also :

$$\frac{Q_1}{Q} = \frac{F_1}{F} \frac{C_1}{C} \quad (3)$$

$$\text{and} \quad \frac{c_1}{c} = \frac{Q_1}{F_1} \div \frac{Q'}{F'} = \frac{Q_1}{Q} \frac{F'}{F_1} \quad (4)$$

because, in general, the velocity ( $c'_1, c'$ ) is equal to the discharge ( $Q'_1 = Q_1, Q' = Q$ ) divided by the area ( $F'_1, F'$ ) of the waterway. Furthermore, the following relations hold good, viz. :

$$Q_1 = (F_1 - F) c_1 + F c + F (c_1 - c) = (F_1 - F) c'_1 + F c' + F (c'_1 - c'),$$

$$Q = F c = F c'$$

$$Q_1 - Q = (F_1 - F) c_1 + F (c_1 - c) = (F_1 - F) c'_1 + F (c'_1 - c') \quad (5)$$

On account of the ever increasing mass of the body of back water from the Atlantic Ocean, which has to be put in motion by the fresh water stream flowing through the estuary, the velocities  $c'$  and  $c'_1$  in the waterways  $b c d b$  and  $a b c d e a$ , become diminished more and more as we proceed down stream towards the Gulf of St. Lawrence, and the ratios  $\frac{c'_1}{c}$  correspondingly increased, in comparison to those that would obtain, if the river was flowing freely over its bed above the mean level of the sea, when no resistance caused by back water would be met with.

With the aid of transverse profiles (see A, B, C on plan attached to this appendix\*) of the river bed, constructed with soundings and other data taken from the Admiralty charts, together with diagrams, (such as Nos. 2 to 8, Ill. No. III.,) showing the geometrical loci of the flood and ebb high and low water levels of the estuary, when these levels are plotted as ordinates with the ranges of the tides taken as abscissas,—for various stages of Lake St. Peter and the river above ; etc,—the areas

$F, F_1$ , and ratios  $\frac{c_1}{c}$  have been computed, approximately at least, as shown on appendices I., II., III. and IV. to this note, for the waterways A B C D E A and B C D B of the fresh water stream proper, which are beyond the upper limit of tidal influence, viz.: on

Lake St. Peter and at a point one-quarter mile above Lanoraie, where the elevation of the bottom of the thalweg appears to be near a maximum. Moreover, the areas  $F$ ,  $F'$ , and ratios  $\frac{F'}{F}$ , for the waterways at the tide stations at the foot of St. James Street, Quebec, Victoria Cove, Pointe au Tremble, Pointe Platon, Grondines, etc., can also be considered as being known quantities.

Now, when the water falls at Sorel from a level of 26.6 ft. to a level 20 ft. above 0 of the Montreal Harbour Commissioners' gauge, viz: 6.6 ft. it is found (see appendices I., II., III., IV.) that the velocity  $c$ , is decreased from 15 to 20 per cent. when as we take cross section A taken near Lanoraie, or one or the other of the sections, B or C, of Lake St. Peter, shown on the accompanying plan, as a basis of computation, that is to say: ( $c_1 - c$ ) becomes equal to: from 0.15  $c$ , to 0.20  $c$ .

Again, at the foot of St. James street, and at Victoria Cove—at both of which the depth is considerable and the effect of the back water on the fresh water is great—the velocity  $c'$ , is decreased for the same change of level at Sorel from 26.6 ft. by the quantity  $\frac{Q F'}{Q F}$ .

(1) Adopting section A as a basis of computation, we find:

At foot of St. James Street, Quebec Harbour:

$$\frac{Q F'}{Q F} = \frac{1 \times 405,470}{1.64 \times 400,400} = 0.618$$

$$c' - c = (0.20 - 0.618)c = -0.418c$$

$$= 4.18 \text{ ft. } \times 0.618 = 2.58 \text{ ft.}$$

$$= 17.45 \text{ ft. } \times 0.618 = 10.78 \text{ ft.}$$

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as it descends from the level corresponding to a river surface 26.6 ft. above the 0 of the Sorel gauge to one only 20.0 ft. above this 0, in which case we can put :

$$D' : d' :: 1 : \frac{c'_1 - c'}{c'_1}$$

whence :

$$D' = \left( \frac{d'}{c'_1 - c'} \right) \quad (6)$$

where  $d'$  represents the lowering of the water at a tide gauging station, which corresponds to the lowering of the river proper at Sorel by 6.6 ft. viz : from 26.6 ft. to 20 ft. on the gauge just mentioned, and  $D'$  the depression caused at the same station by the lowering of the Sorel river level from 26.6 ft. to about 8.0 ft. above 0 on the same gauge, when Lake St. Peter would be nearly dry, which depression is equivalent to 14 ft. at the foot of St. James Street, and 2.4 ft. at Victoria Cove.

Substituting in equation (6) the numerical value for the symbols  $d'$  and  $\frac{c'_1 - c'}{c'_1}$  we obtain :—

1°. For foot of St. James Street, Quebec Harbour :

(a) Taking cross section A as a basis :

$D'_1 = \frac{1.4}{0.382} = 3.66$  ft. below level of tideless estuary 21.9 ft. below 0 of St. James Street gauge of 1882, which level corresponds to river surface 20 ft. above 0, per Sorel gauge.

Depth  $\delta_1$  of mean sea level, below level of tideless estuary just described, corresponding to river surface 20 ft. above 0 of Sorel gauge =  $(3.66 - 1.4) = 2.3$  ft.

(b.) Adopting cross section C as a basis of computation :

$D'_2 = \frac{1.4}{0.544} = 2.58$  ft and  $\delta_2 = (2.58 - 1.4) = \text{say } 1.2$  ft.

2°. For Victoria Cove, Quebec Harbour,

a.) Adopting cross section A :

$D'_3 = \frac{2.4}{0.369} = 6.5$  ft. below level of tideless estuary corresponding to river level above 0, per Sorel gauge.

Depth  $\delta_3$  of mean sea level, below level of tideless estuary just described =  $(6.5 - 1.4) = 4.1$  ft.

(b.) Adopting cross section C as the basis of computation :

$D'_4 = \frac{2.4}{0.534} = 4.50$  ft. and  $\delta_4 = (4.5 - 2.4) = 2.1$  ft.

No computations based on cross section B were made, because the data derived from this section were nearly the same as those obtained by using section C.

The lowest of the mean sea levels thus roughly determined in both places, are respectively those based on cross section A, and the highest those based on cross section C.

If we assume the surface of the tideless estuary to be about level between St. James Street and Victoria Cove, and take the mean of the lowest sea levels just determined,  $\frac{(2.9 + 2.03) + (21.9 + 4.1)}{2} = 25.1$  ft. is found for the average depth of the mean

level below the 0 of the St. James Street gauge of 1882.

But if we suppose that a fall of 0.15 ft. obtains in the tideless stream between the places mentioned, and take the mean of the results which raise the sea level to the greatest height, we find :  $\left( \frac{(21.9 + 1.2) + (21.9 + 2.1)}{2} \right) - 0.15 = 23.40$  ft., for the corresponding probable depth of the mean sea level below the 0 of the St. James Street gauge of 1882.

It appears probable, for the following reasons, that the plane 23.4 ft. below the 0 of the St. James Street gauge of 1882, will be found to coincide more nearly with the actual mean level of the Atlantic Ocean, than the datum plane above established, which is 25.1 below the said 0.

1°. On account of the great width of the Lake St. Peter, the value of the relation

$$\frac{c_1}{c} = \sqrt{\frac{F_1}{P_1}} \times \sqrt{\frac{P}{F}} \text{ for cross section C, is less liable to be vitiated by errors in sound-}$$

ings, etc., than the value of the corresponding relation for cross section A.

2°. The data derived from two cross sections (B and C) which have been constructed with the aid of soundings obtained from two different sources, are nearly identical.

3°. Because a mean sea level (*b*), closely agreeing with that based on a cross section of the tideless estuary at Quebec and one of Lake St. Peter, is also deduced from the following considerations.

The whole declivity in the surface of the tideless estuary may be considered to be due solely to the friction generated by the fresh or drainage water, in passing over the bed of the river, and on any stretch of this estuary between Quebec and the Gulf of St. Lawrence, the area of the longitudinal section taken along its axis, as well as that of any cross section, may be assumed to remain practically invariable for all discharges from 0 to 450,000 cubic feet per second. Hence the total friction head  $h_f$  must, in general,

be nearly directly proportional to the product of the square of the velocity  $v$  by the coefficient of resistance of friction  $c_f$  and also the product of the square of the discharge

$Q$  by the same coefficient  $c_f$ .

That is to say, if  $h_1$  and  $h_2$  represent the friction heads geneted with discharges  $Q_1$ ,  $Q_2$ , corresponding, respectively, to depths of 17.1 ft. and 22.9 ft. over mitre sill of lock No. 1, Lachine Canal, and water levels 26.58 and 20.68 above the 0 of the Montreal Harbour Commissioners gauge at Sorel, and  $c_1$ ,  $c_2$ , the mean coefficients of friction corresponding to the velocities  $V_1$ ,  $V_2$ , which obtain in each case, we must have nearly :

$$h_1 : h_2 :: Q_1^2 : Q_2^2, \text{ and also, } h_1 : (h_2 - h_1) :: Q_1^2 : [Q_2^2 - Q_1^2]$$

$$\text{whence } h_1 = \frac{[h_2 - h_1] Q_1^2}{Q_2^2 - Q_1^2}$$

Now it appears from diagrams of high and low water loci, similar to Nos. 2 to 8 constructed for high and low stages of the River St. Lawrence in 1881-82, that for a fall in the river level from 26.58 ft. to 20.68 ft. above the 0 of Montreal-Harbour Commissioners' gauge at Sorel, the variation in the friction head was at Quebec about 1.2, that is to say, we have:  $h_2 - h_1 = 1.2$  ft. nearly.

Again, from data taken from the report made by the late Thos. Guérin, Esq. civil engineer, under date of 12th March, 1883, in relation to the proposed hydraulic works in the harbour of Montreal known as the "Shearer scheme" (See printed Report of Minister of Public Works for the fiscal year 1882-83, Appendix No. 10, page 124), I have deduced the following :—

(a.) Between 25th May and 6th June, 1882, when the river stood at a mean elevation of 26.58 ft. per Montreal Harbour Commissioners' Sorel gauge, the mean depth of water on the sill of lock No. 1, Lachine Canal, was 22.9 ft.

(b.) Between 6th November and 5th December, 1882, when the river stood at a mean height of 20.68 ft. per Sorel gauge, the mean depth of water on the same lock sill, was 17.1 ft.

Average fall of river from average high water in spring, to average low water in autumn, equal to 5.9 ft. at Sorel, and 5.8 ft. at Montreal, foot of Lachine Canal.

Discharge  $Q'_2$  computed by Mr. Guerin for high river level of 6th June, when water stood 2.75 ft. over 0 at Sorel and 23.5 ft. over sill, old lock, No. 1, at Montreal = 431,733 ft. cube per second.

Discharge  $Q'_1$ , as computed by Mr. Guerin for low water level of 24th November, 1882, with river at 21.1 at Sorel, and 17.5 ft. on sill lock No. 1, at Montreal = 281,581 ft. cube per second.

Mean depth  $d'_2$  of channels, north and south sides of St. Helen's Island, 6th June, 1882, =  $\frac{84 \cdot 019^{sq. ft.}}{4 \cdot 949^{sq. ft.}} = 16.97$  ft.

Mean depth  $d'_1$  of same channels, 24th November, 1882 =  $\frac{59 \cdot 550^{sq. ft.}}{4 \cdot 350} = 13.69$  ft.

Discharges  $Q_2$  and  $Q_1$  corresponding to river levels, respectively, 22.9 ft. and 17.1 ft. above the lock sill, instead of 23.5 and 17.5, have been arrived at as follows:—

Mean depth  $d'_2$  for 22.9 ft. on lock sill = say : 16.07 ft.

Mean depth  $d'_1$  for 17.1 ft. on lock sill = say : 13.09 ft.

The decrease in volumes of discharges, as determined by Weisbach's approximate formula, are :

$$\frac{Q_1 - Q'_1}{Q_1} = \frac{3}{2} \left( \frac{d_1 - d'_1}{d'_1} \right) = \frac{3}{2} \left( \frac{0.60}{13.69} \right) = 0.0657, \text{ whence :}$$

$$Q'_1 = 281,581 - (0.0657)(281,581) = 263,081 \text{ cubic ft., and}$$

$$\frac{Q_2 - Q'_2}{Q_2} = \frac{3}{2} \left( \frac{d_2 - d'_2}{d'_2} \right) = \frac{3}{2} \left( \frac{0.90}{16.97} \right) = 0.0795, \text{ whence :}$$

$$Q'_2 = 431,733 - (0.0795)(431,733) = 397,410 \text{ cubic ft.}$$

By applying the same formula to the determination of the discharge  $Q_3$ , corresponding to 23.5 ft. depth on sill of lock No. 1, by means of the discharge computed by Mr. Guerin for a depth of 17.5 ft., and the increased dimensions of the waterway which obtained when the river was 6.0 ft. higher, it is found that

$$Q_3 = 281,581 + (0.3595 \times 281,581) = 382,809 \text{ cubic ft.,}$$

instead of 431,733 cubic ft. per second, the discrepancy being 48,924 ft. cube—due to variation in width of waterway, etc.

By assuming that the error varies in an approximate manner directly as the increase of depth in each case, we have

$$\text{Error for } \{(d_2 - d'_2) = 0.9 \text{ ft.}\} = \frac{48,924 \times 0.9}{6.0} = 7339, \text{ and}$$

$$\text{Error for } \{(d_1 - d'_1) = 0.6 \text{ ft.}\} = \frac{48,924 \times 0.6}{6.0} = 4892.$$

$Q_2$  thus becomes :  $397,410 - 7339 = 390,071$ , and  $Q_1$  becomes :  $263,081 - 4892 = 258,189$ , or in round numbers, we may put :

$$Q_2 = 390,000 \text{ ft. cube, and}$$

$$Q_1 = 260,000 \text{ ft. cube.}$$

There remains to be determined the value of  $c'_1$  and  $c'_2$ , or, strictly speaking only their relative or proportional values for velocities which bear to each other the ratio of 39 to 26, or 3 to 2.

At Quebec the area  $a''_2$  of the tideless estuary is, for river surface 26.58 ft. above 0 of Montreal Harbour Commissioners' gauge at Sorel, approximately : 405,000 sq. ft., whence, velocity  $v''_2$  corresponding to discharge  $Q_2$  is deduced to be 0.963 ft. per second, and  $v''_1$  corresponding to discharge  $Q_1$ , 0.642 ft. nearly.

According to J. Neville's hydraulic tables, coefficients and formulæ, page 229, the coefficients of resistance for friction in pipes corresponding to these velocities are to each other nearly as 0.009133 to 0.008117, and for large rivers the coefficients of resistance for velocities within narrow limits, bear to each other ratios not materially different from

those which obtain for pipes under the same conditions. But by taking in the whole estuary below Quebec down to the Gulf, the mean velocities would be, of course, much smaller than those just mentioned, and for smaller velocities of the same relative values, the coefficients  $c$ , increase more rapidly than the velocities decrease: but according to what precise law this decrease takes place is not definitely known. The smallest velocity for which a coefficient is given by Neville is 0.1 ft. per second; its value being 0.017159.

If we suppose, judging by the soundings, etc., on the Admiralty Charts, etc., that the average velocities corresponding to discharges  $Q_1$  and  $Q_2$  are 0.2 and 0.3 ft. per second between Quebec and the Gulf, which is, in each case, say between  $\frac{1}{5}$  and  $\frac{3}{10}$  of the velocity that would obtain in the vicinity of Quebec city, the coefficients  $c_1$  and  $c_2$  become: 0.013186 and 0.011427.

By substituting in equation (x) the numerical values just determined for the symbols, we find, having divided each discharge by 10,000 before squaring:

$$h_1 = \frac{1.2 \times 67.6 \times 0.013186}{152.1 \times 0.011427 - 67.6 \times 0.013186} = 1.27 \text{ ft.}$$

That is to say with a discharge  $Q_1$  of 260,000 cubic ft. per second, the level of the estuary abstracted from the influence of the tides would stand opposite Quebec city 1.27 ft. above the mean level of the Atlantic Ocean in the Gulf of St. Lawrence, a result which agrees tolerably well with 1.2 ft., the value arrived at for  $\delta_2$ , the depth of the mean sea level below level of tideless estuary at Quebec corresponding to river surface 20 ft. above the 0 of the Montreal Harbour Commissioners' gauge at Sorel.

R. STECKEL

## APPENDIX I TO NOTE A.

COMPARISON of River levels at Contrecoeur, Lavaltrie and Sorel, extracted from gauge registers kept under the supervision of the Montreal Harbour Commissioners.—  
(John Kennedy, Chief Engineer.)

Dates.	Contrecoeur and Lavaltrie.			Sorel.			Dif- ference.	Average dif- ference in each year.	Maximum devia- tion from average in each year.
	Maximum	Minimum	Average	Maximum	Minimum	Average			
1878.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
Nov. 18-23	23.5	22.2	22.5	23.3	22.0	22.3	0.2	3.5	0.15
do 25-30	24.0	23.5	23.8	23.6	23.3	23.3	0.5		
1879.									
Sept. 16-30	25.7	25.2	25.4	21.0	20.1	20.6	4.8	4.9	0.1
Oct. 1-25	25.3	24.3	24.8	20.3	19.3	19.9	4.9		
do 26-31	24.5	24.0	24.2	19.5	18.8	19.2	5.0		
Nov. 1-7	24.3	23.8	24.1	19.5	18.9	19.3	4.8		
1880.									
May 3-6	32.3	32.0	32.2	26.7	26.4	26.5	5.7	5.6	0.3
July 26-31	27.4	26.5	27.0	21.7	21.2	21.6	5.4		
Oct. 1-4	25.5	25.2	25.4	20.3	19.5	19.8	5.6		
do 13-30	26.4	25.2	25.6	20.6	19.7	20.1	5.5		
Nov. 1-11	27.2	26.3	26.8	21.8	20.1	20.9	5.9		
do 12-22	28.5	27.3	28.1	23.0	21.2	22.4	5.7		
1881.									
April 25-30	29.2	27.7	28.4	23.6	22.3	22.8	5.6	5.8	0.3
May 1-12	30.5	29.5	29.7	24.7	23.6	23.9	5.8		
do 13-14	31.3	31.3	31.3	25.8	25.4	25.6	5.7		
do 18-21	33.7	33.0	33.4	27.5	27.1	27.3	6.1		
do 23-30	32.5	30.7	31.6	26.3	24.8	25.6	6.0		
June 1-7	30.3	29.0	29.7	24.5	23.0	23.8	5.9		
Oct. 11-31	25.4	24.6	25.1	19.8	18.9	19.3	5.8		
Nov. 1-25	25.7	24.9	25.3	20.0	19.2	19.6	5.7		

The above shows that for the years 1880-81, during which the observations registered were most numerous, extending over, we may say, the whole season of navigation, the water fell about 0.3 ft. more at Lavaltrie than at Sorel—or what is probably more correct, the water was raised 0.3 ft. more at Sorel by the tides, than at Lavaltrie and Contrecoeur. This difference, it will be noticed, has been taken into account in calculating the area of the waterway at Lanoraie (A) corresponding to a river level 26.6 ft. above 0 at Sorel; the fall of the St. Lawrence from 26.6 to 19.3 ft. = 7.3 ft. at Sorel, being taken at 7.7 ft. at Lanoraie.

## APPENDIX II TO NOTE A.

COMPUTATION of area F, etc., for waterway at a point  $1\frac{1}{2}$  miles west of *Lamorne*, where elevation of bottom of thalweg is near a maximum according to soundings given on Admiralty Chart No. 2779 of St. Lawrence above Quebec. •

Distances North & South shore with 19.3 ft. on Lake St. Peter Flats.		Intermediate distances.	Average depths of sections for 10 ft. on flats at Lake St. Peter.	Areas of Sections.	Data for establishing approximate position of mean sea level.
ft.	ft.	ft.	ft.	sq. ft.	
0	30	30	1	30	
30	30	30	1	30	
60	30	30	1	30	
90	30	30	1	30	
120	30	30	1	30	
150	30	30	1	30	
180	30	30	1	30	
210	30	30	1	30	
240	30	30	1	30	
270	30	30	1	30	
300	30	30	1	30	
330	30	30	1	30	
360	30	30	1	30	
390	30	30	1	30	
420	30	30	1	30	
450	30	30	1	30	
480	30	30	1	30	
510	30	30	1	30	
540	30	30	1	30	
570	30	30	1	30	
600	30	30	1	30	
630	30	30	1	30	
660	30	30	1	30	
690	30	30	1	30	
720	30	30	1	30	
750	30	30	1	30	
780	30	30	1	30	
810	30	30	1	30	
840	30	30	1	30	
870	30	30	1	30	
900	30	30	1	30	
930	30	30	1	30	
960	30	30	1	30	
990	30	30	1	30	
1020	30	30	1	30	
1050	30	30	1	30	
1080	30	30	1	30	
1110	30	30	1	30	
1140	30	30	1	30	
1170	30	30	1	30	
1200	30	30	1	30	
1230	30	30	1	30	
1260	30	30	1	30	
1290	30	30	1	30	
1320	30	30	1	30	
1350	30	30	1	30	
1380	30	30	1	30	
1410	30	30	1	30	
1440	30	30	1	30	
1470	30	30	1	30	
1500	30	30	1	30	
1530	30	30	1	30	
1560	30	30	1	30	
1590	30	30	1	30	
1620	30	30	1	30	
1650	30	30	1	30	
1680	30	30	1	30	
1710	30	30	1	30	
1740	30	30	1	30	
1770	30	30	1	30	
1800	30	30	1	30	
1830	30	30	1	30	
1860	30	30	1	30	
1890	30	30	1	30	
1920	30	30	1	30	
1950	30	30	1	30	
1980	30	30	1	30	
2010	30	30	1	30	
2040	30	30	1	30	
2070	30	30	1	30	
2100	30	30	1	30	
2130	30	30	1	30	
2160	30	30	1	30	
2190	30	30	1	30	
2220	30	30	1	30	
2250	30	30	1	30	
2280	30	30	1	30	
2310	30	30	1	30	
2340	30	30	1	30	
2370	30	30	1	30	
2400	30	30	1	30	
2430	30	30	1	30	
2460	30	30	1	30	
2490	30	30	1	30	
2520	30	30	1	30	
2550	30	30	1	30	
2580	30	30	1	30	
2610	30	30	1	30	
2640	30	30	1	30	
2670	30	30	1	30	
2700	30	30	1	30	
2730	30	30	1	30	
2760	30	30	1	30	
2790	30	30	1	30	
2820	30	30	1	30	
2850	30	30	1	30	
2880	30	30	1	30	
2910	30	30	1	30	
2940	30	30	1	30	
2970	30	30	1	30	
3000	30	30	1	30	
3030	30	30	1	30	
3060	30	30	1	30	
3090	30	30	1	30	
3120	30	30	1	30	
3150	30	30	1	30	
3180	30	30	1	30	
3210	30	30	1	30	
3240	30	30	1	30	
3270	30	30	1	30	
3300	30	30	1	30	
3330	30	30	1	30	
3360	30	30	1	30	
3390	30	30	1	30	
3420	30	30	1	30	
3450	30	30	1	30	
3480	30	30	1	30	
3510	30	30	1	30	
3540	30	30	1	30	
3570	30	30	1	30	
3600	30	30	1	30	
3630	30	30	1	30	
3660	30	30	1	30	
3690	30	30	1	30	
3720	30	30	1	30	
3750	30	30	1	30	
3780	30	30	1	30	
3810	30	30	1	30	
3840	30	30	1	30	
3870	30	30	1	30	
3900	30	30	1	30	
3930	30	30	1	30	
3960	30	30	1	30	
3990	30	30	1	30	
4020	30	30	1	30	
4050	30	30	1	30	
4080	30	30	1	30	
4110	30	30	1	30	
4140	30	30	1	30	
4170	30	30	1	30	
4200	30	30	1	30	
4230	30	30	1	30	
4260	30	30	1	30	
4290	30	30	1	30	
4320	30	30	1	30	
4350	30	30	1	30	
4380	30	30	1	30	
4410	30	30	1	30	
4440	30	30	1	30	
4470	30	30	1	30	
4500	30	30	1	30	
4530	30	30	1	30	
4560	30	30	1	30	
4590	30	30	1	30	
4620	30	30	1	30	
4650	30	30	1	30	
4680	30	30	1	30	
4710	30	30	1	30	
4740	30	30	1	30	
4770	30	30	1	30	
4800	30	30	1	30	
4830	30	30	1	30	
4860	30	30	1	30	
4890	30	30	1	30	
4920	30	30	1	30	
4950	30	30	1	30	
4980	30	30	1	30	
5010	30	30	1	30	
5040	30	30	1	30	
5070	30	30	1	30	
5100	30	30	1	30	
5130	30	30	1	30	
5160	30	30	1	30	
5190	30	30	1	30	
5220	30	30	1	30	
5250	30	30	1	30	
5280	30	30	1	30	
5310	30	30	1	30	
5340	30	30	1	30	
5370	30	30	1	30	
5400	30	30	1	30	
5430	30	30	1	30	
5460	30	30	1	30	
5490	30	30	1	30	
5520	30	30	1	30	
5550	30	30	1	30	
5580	30	30	1	30	
5610	30	30	1	30	
5640	30	30	1	30	
5670	30	30	1	30	
5700	30	30	1	30	
5730	30	30	1	30	
5760	30	30	1	30	
5790	30	30	1	30	
5820	30	30	1	30	
5850	30	30	1	30	
5880	30	30	1	30	
5910	30	30	1	30	
5940	30	30	1	30	
5970	30	30	1	30	
6000	30	30	1	30	
6030	30	30	1	30	
6060	30	30	1	30	
6090	30	30	1	30	
6120	30	30	1	30	
6150	30	30	1	30	
6180	30	30	1	30	
6210	30	30	1	30	
6240	30	30	1	30	
6270	30	30	1	30	
6300	30	30	1	30	
6330	30	30	1	30	
6360	30	30	1	30	
6390	30	30	1	30	
6420	30	30	1	30	
6450	30	30	1	30	
6480	30	30	1	30	
6510	30	30	1	30	
6540	30	30	1	30	
6570	30	30	1	30	
6600	30	30	1	30	
6630	30	30	1	30	
6660	30	30	1	30	
6690	30	30	1	30	
6720	30	30	1	30	
6750	30	30	1	30	
6780	30	30	1	30	
6810	30	30	1	30	
6840	30	30	1	30	
6870	30	30	1	30	
6900	30	30	1	30	
6930	30	30	1	30	
6960	30	30	1	30	
6990	30	30	1	30	
7020	30	30	1	30	
7050	30	30	1	30	
7080	30	30	1	30	
7110	30	30	1	30	
7140	30	30	1	30	
7170	30	30	1	30	
7200	30	30	1	30	
7230	30	30	1	30	
7260	30	30	1	30	
7290	30	30	1	30	
7320	30	30	1	30	
7350	30	30	1	30	
7380	30	30	1	30	
7410	30	30	1	30	
7440	30	30	1	30	
7470	30	30	1	30	
7500	30	30	1	30	
7530	30	30	1	30	
7560	30	30	1	30	
7590	30	30	1	30	
7620	30	30	1	30	
7650	30	30	1	30	
7680	30	30	1	30	
7710	30	30	1	30	
7740	30	30	1	30	
7770	30	30	1	30	
7800	30	30	1	30	
7830	30	30</			

## APPENDIX III TO NOTE A.

COMPUTATION of area F, etc., for waterway across flats at Lake St. Peter, viz., where elevation of bottom is near a maximum according to ice soundings given on Montreal Harbour Commissioners chart, dated 1855.

Distances North to South with 11 ft. on Lake St. Peter Flats.		Intermediate distances.	Average depths of sections for 11 feet on flats, Lake St. Peter.	Area, Square Feet.	Data for establishing approximately position of mean sea level.
ft.	ft.	ft.	ft.	sq. ft.	
0	to 2300	2300	3	5720	
2300	" 5500	3200	4	20800	
5500	" 8900	3400	5	28900	
8900	" 11400	2500	9	22500	
11400	" 12600	1200	12	11400	
12600	" 14000	1400	11	14700	
14000	" 15360	1360	21.5	15664	
15360	" 15690	330	25	8250	Ship channel deepened to 25 feet at ordinary summer water.
15690	" 18000	2310	15	26565	
18000	" 19200	1200	24.6	14760	
19200	" 20200	1000	24	12500	
20200	" 23700	3500	12	42000	
23700	" 24700	1000	12	11500	
24700	" 29000	4300	11	47300	
29000	" 29500	500	24	5250	
29500	" 30200	700	12	6650	
30200	" 31200	1000	12	8500	Wetted perimeter for 11 ft. } $p = \text{say } 35040 \text{ ft.}$ of water on flats.
31200	" 32000	800	12	5600	
32000	" 32800	800	12	4400	Mean depth for 11 ft. on flats. } $\frac{318480}{35000} = 9.1 \text{ ft.}$
32800	" 35000	2200	12	5500	
Total area F, for 11 feet water on flats corresponding to water surface at 20 feet above 0, Sorel gauge.				318489	
Add:					
For area F of waterway with lake surface 26.6 feet above Sorel gauge.					
Add:					
North shore--					
Feet.			Area,		
			Sq. feet.		
$1600 \times \frac{6.6}{2} =$			5290		
South shore--					
$4000 \times \frac{6.6}{2} =$			13200		
Centre--					
$35000 \times 6.6 =$			231000		
				249480	
Total area F, for 17.6 feet water on flats corresponding to water surface at 26.6 feet above 0, Sorel gauge.				567969	
Velocity ratio } $C_1 = \frac{568,000 \times 35040}{318,500 \times 40650} = 1.2385$					
according to formula (2).					
Discharge ratio } $\frac{Q_1}{Q} = \frac{F_1 C_1}{F C} = 2.2111$					
according to formula (3).					
$\frac{C Q_1}{C Q} = 1.78336$					
Mean depth for 17.6 ft. on flats. } $\frac{567969}{40600} = 13.99 \text{ feet.}$					

## APPENDIX IV. TO NOTE A.

COMPUTATION of Area F, etc., for waterway across flats of Lake St. Peter, viz.: where elevation of bottom is near a maximum according to soundings given on Admiralty chart No. 2781 of the lake, dated 1859.

North to South.	Distance, in feet for 10.3 ft. on Lake St. Peter flats.	Average depth in feet for 10.3 ft. on Lake St. Peter flats.	Area, Square Feet.	Data for establishing approximately, position of Mean Sea Level, etc.
1400	3000	1600	4 = 3200	
3000	5470	2470	5 = 14850	
5470	7000	1530	8 = 12240	
7000	8500	1500	17 = 12750	
8500	13750	5250	9 = 47520	
13750	15000	1250	10 = 11500	
15000	15700	700	10 = 7000	
15700	16100	400	24 = 9600	Ship channel deepened to 24 ft. at ordinary low summer water.
16100	16500	400	10 = 4000	
16500	17100	600	10 = 5700	
17100	18300	1200	5 = 12000	
18300	28150	9850	11 = 108350	
28150	28350	1200	5 = 12000	
28350	30380	1030	5 = 5150	
30380	31450	1070	5 = 5350	
31450	33630	2480	6 = 14880	
33630	34830	900	10 = 4950	
34830	35730	900	5 = 4500	
35730	37100	1370	1 = 1370	

Total area for 10.3 ft. water on flats corresponding to water surface at 19.3 ft. above 0, Survey gauge.

303635

For waterway—with 11 ft. depth on flats, add:  
North side—

Ft.

$$140 \times \frac{7}{2} = \dots \dots \dots 490$$

South side—

$$250 \times \frac{7}{2} = \dots \dots \dots 875$$

$$37100 - 1400 = 35700 \quad 7 = \dots \dots \dots 249900$$

Wetted perimeter for 11 ft. water on flats. }  $P = \text{say } 36190 \text{ ft.}$

Total area F for 11 ft. water on flats corresponding to water surface at 20 ft. above 0, Survey gauge.

$$\frac{328775.5}{36130} \text{ Mean depth for 11 ft. } = \frac{328775.5}{36130} = 9.1 \text{ ft. on flats.}$$

North side

Ft.

$$1650 \times \frac{7.3}{2} = \dots \dots \dots 60225$$

South side

$$2380 \times \frac{7.3}{2} = \dots \dots \dots 8687.0$$

$$35700 \times 7.3 = \dots \dots \dots 260610.0$$

Wetted perimeter of }  $P_1 = \text{say } 37760 \text{ ft. water on flats.}$

$$\text{Velocity ratio } \left\{ \begin{array}{l} C_1 = \frac{57860 \times 3616}{C \sqrt{328940 \times 39760}} = 1.36400 \\ \text{according to formula 21.} \end{array} \right.$$

Add area for 10.3 ft. level as above

303635.0

Total area F for 17.6 ft. water on flats, corresponding to water surface at 26.6 ft. above 0, Survey gauge.

578854.5

$$\left\{ \begin{array}{l} \text{Discharge ratio} \\ \text{according to formula 31.} \end{array} \right. \frac{Q_1}{Q} = \frac{F_1 c}{F c} = 2.22564$$

Mean depth for W.S. 26.6 ft. above 0, Survey gauge, or 17.6 ft. on flats. } = 14.37 ft.

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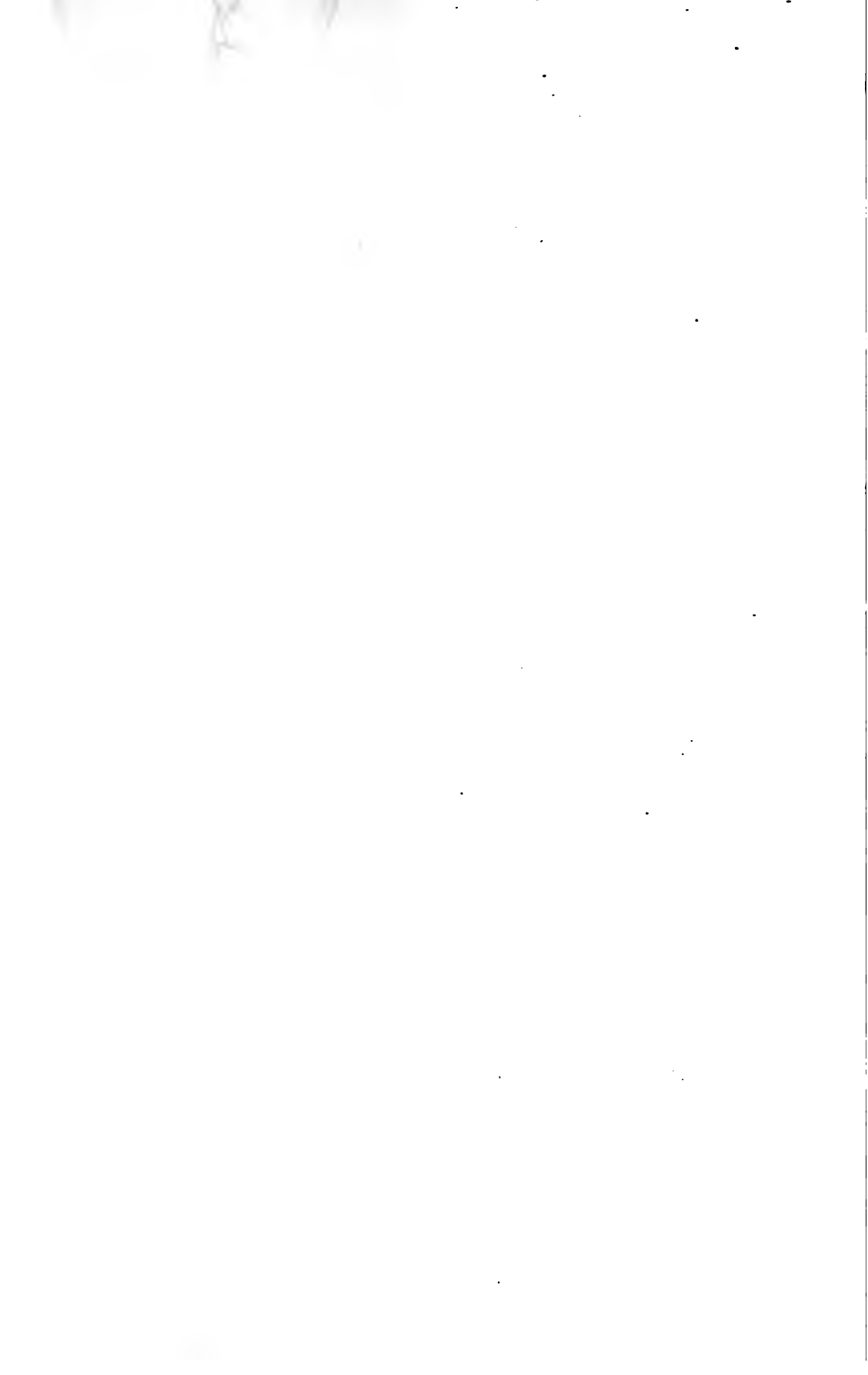
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